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ADDRESS OF THE PRESIDENT OF THE ROYAL SOCIETY[1]

By Sir HENRY DALE, C.B.E.

FULLERIAN PROFESSOR AND DIRECTOR OF THE LABORATORIES OF THE ROYAL INSTITUTION, LONDON

WE are to-day within a few weeks of the three hundredth anniversary of the birth of Isaac Newton. Wherever the progress of our Western science and philosophy has become effective, men will remember what that event was to mean for the world. Newton, as we shall hear, at the age of forty-three, when he had determined to abandon all further concern with natural philosophy, was induced at length, by Halley's friendly insistence, to give written form and system to the mathematical discoveries with which his amazing mind had been occupied over a period of some twenty years. The result was one of the greatest intellectual achievements in the history of mankind—the "Principia," providing for more than two centuries a framework for the mechanical interpretation of the universe and a basis for the building of physical science, and therewith of the material structure of our modern civilization.

We in Britain regard Isaac Newton as still, beyond challenge, the greatest of our men of science. Nor should the claim be limited to this island or to the British commonwealth of nations; for it was not till nearly half a century after Newton's death that former British colonists in North America began their development of an independent nation; and Newton is theirs as well as ours.

But, while we may proudly claim him as the countryman of all who share the birthright of the English tongue, the discoveries of science have belonged, and must belong again, to the whole world, and Newton's achievement is a part of the common heritage of all peoples. It can not be doubted that, if it had fallen in normal times, this tercentenary would have been

[1] Anniversary meeting, November 30, 1942.

marked by the greatest of international gatherings, in which men of science and philosophers from all the world would have assembled to do honor to Newton's memory. It would have been natural then to expect leadership, in such an enterprise, from the only two institutions which were intimately concerned with Newton's career as a man of science—Trinity College, in Cambridge, and this our Royal Society of London. Our two foundations did, indeed, confer as to the wisdom of attempting by joint action, even in this year of war, to arrange such a restricted and domestic celebration as the present conditions would allow. We agreed, however, to put aside such planning for the present, carrying it forward in our hopes to the time when a world at peace may be able to join in international commemoration of an event which has meant so much for all mankind. May the time be not too far distant.

To-day we are holding the two hundred and eightieth anniversary meeting of the Royal Society, on Saint Andrew's Day as by regular custom, ever since the first meeting on that day in 1662. It seemed to us that we should depart, on this occasion, a little from the usual order of our proceedings, so that, on a day so near to the tercentenary of his birth, our Fellows and our guests may be reminded of Newton. We have accordingly asked three of our Fellows to address the society on different aspects of Newton's work, in its relations to the science of the past and the present. We have asked Professor Andrade to give us the opportunity of understanding the magnitude of the change which Newton's work produced, in the conceptions of the material universe which were current in his own times. We know that to his contemporaries Newton's discoveries came as a great revelation, and we hope that Professor Andrade will help us to understand why they did so. We have asked Lord Rayleigh to deal, by demonstration where possible, with the experimental work of Newton and the great discoveries which he made by that method. This is an aspect of his greatness which popular estimates have tended to overlook; but I think that Lord Rayleigh will be able to convince us that Newton as an experimenter would have had claims to a place among our greatest men of science, even if he had failed, as he so nearly did fail, to write the "Principia." And, finally, we have asked Sir James Jeans to give us some reassessment of the validity and permanence of Newton's system, in relation to the immense advances of knowledge in our own times. There are many who have not the mathematical equipment to follow them in detail, who are nevertheless aware that revolutionary changes have been taking place in conceptions of the mechanics of the universe and of its ultimate material units. How is the Newtonian system affected by the discoveries which have required the general theory of relativity and the quantum mechanics at opposite ends of the stupendous scale? Is it being supplemented, modified or superseded after its centuries of dominance? We hope that Sir James Jeans will tell us; and we may remember, perhaps with comfort, that Newton's "Principia" seemed difficult and abstruse to his contemporaries, and that he even confessed that he had made it so deliberately, "to avoid being bated by little smatterers in mathematics."

Before I call on our chosen lecturers to address us, there are two other matters relating to Newton and the Royal Society, which it seems proper to mention here. In the hamlet of Woolsthorpe, near Colsterworth on the Great North Road, some six miles south of Grantham, there is still a modest manor farm-house, with a small orchard in front of it. Here the Newtons lived, simple yeoman farmers, and here, two months after his father had died, Isaac Newton was born, a puny, premature infant, on Christmas day, 1642, twenty years before the Royal Society was incorporated by the grant of its first charter. The house stands but little altered since that day. The room in which Newton was born has a simple marble tablet on the wall, inscribed with Pope's well-known couplet. But this house had importance in Newton's later life and in his work, and not only as his birthplace. It was here that he returned from his schooling at Grantham, at the age of sixteen, to take charge of the farm for his mother; and here, to the incalculable gain of science and the world, he showed such incompetence as a farmer that he was sent back to school, and thence to Cambridge. It was here, again, that he returned in the autumn of 1665, when the plague drove him from Cambridge; and here, during the following eighteen months of quiet exile in the country, his early ripening genius grasped already the essential principles of his major theoretical discoveries. You can still see the upper chamber which he then used as a study; and in the little orchard there is an old, recumbent apple tree, which, they will tell you, is descended by direct grafting from that which Newton saw. The land which Newton's family farmed is rapidly being laid waste, alas, by quarrying for ironstone; and soon there will be little left unspoiled save the orchard and garden round the house. It has seemed to us that, in this year of commemoration, something should be done to preserve for posterity a house and garden which carry such momentous memories, and which have meant so much for science. We have accordingly formed a small committee, in which Sir John Russell and Sir James Jeans have joined with the officers of the Royal Society; and we are in negotiation with the lord of the manor as to the possibility of acquiring this now tiny but historic property, so

that it may be put for as long as possible beyond the risk of damage or decay.

Then I think that it is our special duty here, at this anniversary meeting, to remember that, while Newton's great discoveries belong to the world, they came to publication through the Royal Society, and that Newton occupied its presidential chair for the last twenty-four years of his long life. Though his "Optiks" was not published till after he had become president, his original work for science was practically finished by the time of his election, and he had for some years been master of the Mint. There can be no doubt, however, that the wide fame of his achievements, and the respect and admiration in which he was everywhere held, did much, at a critical period in its history, to establish the prestige of this society in the eyes of the world. Let us then remember to-day that Isaac Newton, the greatest man of science of our race, was also the greatest of the Royal Society's presidents.

AWARD OF MEDALS, 1942

The Copley Medal is awarded to Sir Robert Robinson. He is recognized in all countries as one of the world's leaders in organic chemistry, and is one of the greatest and most versatile of investigators in that department of science. His researches, with a long and notable succession of pupils and collaborators, have covered a remarkably wide range of problems in this field, and his approach to these have been distinguished by brilliance in conception and a genius for the selection of methods leading to the desired solutions.

Robinson's investigations have been particularly concerned with the chemistry of natural substances, products of the life processes of plants and animals. His work has thus been a potent factor in the tendency of organic chemistry to return, in recent years, to an objective nearer to that of its origin, and to make contacts of growing intimacy and value with biochemistry, a more recent development in response to the stimulus of functional biology.

This occasion does not permit any attempt at a complete or detailed survey of all the different fields which Robinson's work has illuminated and opened to further exploration. Special mention must be made, however, of his long series of fundamental investigations on the constitution and relationships of the plant alkaloids. His theory of the biogenesis of plant products seems rather to have inspired than to have resulted from his own early and elegant synthesis of tropinone; and it has revealed an unforeseen and coherent relationship between the constitutions of different groups of alkaloids, and given a great stimulus to work on their synthesis. The work published from Robinson's laboratory has been fundamental to understanding of the isoquinoline and the indole series of alkaloids, of morphine and its allies, and of the structural formulae of strychnine and brucine, which formed the subject of his Bakerian Lecture.

Of at least equal scientific rank is the work which Robinson carried out and inspired over many years on the anthocyanin and, more recently, on the anthoxanthin pigments of plants, culminating in the synthesis of the actual coloring matters of flowers, and forming as a whole one of the most brilliant achievements in the whole range of modern organic chemistry.

Robinson's mastery of synthetic resources, and his penetrating instinct for clues to organic constitution, have been further demonstrated in a more recent approach to the synthesis of the steroids, in the production of series of compounds of interest for chemotherapy, and in notable studies of individual natural substances of a range of other types. He is, moreover, a philosopher as well as a master of experimental possibilities; and his theory of organic reactions, in the modern, electronic terms of valency bonds, has had a great influence on the development of fundamental conceptions in organic chemistry.

The Copley Medal is the highest recognition of scientific achievement in the Royal Society's gift, with no limitations of subject or nation; and the society may well find cause for satisfaction in the knowledge that the award of its premier medal for achievement in organic chemistry, after an interval of many years, finds among its own Fellows a recipient of such unquestioned preeminence as Sir Robert Robinson.

The Rumford Medal is awarded to Dr. G. M. B. Dobson. The Rumford Medal awarded by the Royal Society was established for the recognition of important discoveries made in Europe, especially on heat or on light. These conditions appear to be met with a special fitness in the award of the medal this year to Dr. G. M. B. Dobson, for his meteorological researches and discoveries. For Dobson's work has, in recent years, greatly extended knowledge of the linkage between the behavior of ozone and cyclonic disturbances, in that complicated heat engine which is the earth's atmosphere; while light may be said to have provided the basis of measurement for Dobson's spectrographic studies of the distribution of ozone, in time and in height above the earth's surface. Light had also a major concern in earlier researches on meteors in which Dobson collaborated with Professor Lindemann (now Lord Cherwell); in these, the study of the heights between which meteors become luminescent enabled them to draw conclusions as to the density, and from these as to the temperature of the atmosphere at great heights from the earth's surface. But it is especially on Dr. Dobson's own studies of the

ozone of the atmosphere, continued over many years and producing results of outstanding importance for meteorology, that the award is based.

A Royal Medal is awarded to Professor W. N. Haworth, a brilliant leader in organic chemistry. Haworth's great claim to distinction arises from the revolutionary change which has been produced by his own investigations, and by those of his immediate pupils, in the whole aspect of an important section of organic chemistry, dealing with the structure and the relationships of the carbohydrates. The ring structure of the simple sugars, first proposed by Tollens and supported by the work and the authority of Emil Fischer, had been generally regarded by chemists as firmly established. Detecting insecurities in the arguments which led to this formulation, Haworth developed the methylation technique, first used by Purdie and Irvine, and applied it systematically to the monosaccharides. He was thus able to show, by unequivocal methods of organic chemistry, that the accepted ring structure of these sugars was incorrect, and that, in their normal and reactive forms, they were derivatives of pyran and of furan, respectively.

Later Haworth further developed his methods in application to sugars and carbohydrates of increasing complexity. By his work, and that of others who have followed his lead, the detailed structures of many disaccharides and of some trisaccharides have been established. Progress has further been made in his attack on the structural complexities of the polysaccharides, and a simple chemical method has been evolved for determining their minimal molecular weights. Professor Haworth's work, in the field which he has thus made his own, has received the high international recognition of a Nobel Prize, and will assuredly take rank as a major achievement of permanent significance in chemical history.

A Royal Medal is awarded to Dr. W. W. C. Topley, who is one of the most distinguished of the British bacteriologists of recent years. The most important of Topley's contributions to bacteriology and experimental medicine has been the experimental study of epidemics, which he initiated and of which the methods have been largely his own creation. Much had been learned by the statistical analysis of observational data, dealing with the origin, spread and development of natural epidemics, under conditions largely out of control. Topley conceived the idea of applying such methods to the investigation of epidemics started artificially in populations of healthy mice, kept in the laboratory under conditions which could be exactly controlled and deliberately varied. Thus the factors conducive to the rise, culmination and decline of an epidemic, to its revival or its final subsidence, could be experimentally determined. In a long series of such studies, the important results of which were reviewed in his Croonian Lecture for 1941 on "The Biology of Epidemics," Topley had the statistical cooperation of Professor Major Greenwood, in both planning and interpretation.

On this firm basis of knowledge concerning the incidence and mortality of a naturually transmitted infection in untreated stock, the efficiency of prophylactic measures could be put to a controlled test. Under Topley's guidance and inspiration, accordingly, substantial progress had been made by his chemical colleagues towards the isolation from various species of pathogenic bacteria of highly purified and stable antigens, and the practical trial of some of these was interrupted by the outbreak of war.

Dr. Topley's researches have had a great and lasting influence on the study of bacteriology, immunology and epidemiology in relation to human medicine. His recent change of the focus of his interests may be expected to give an important stimulus to advance in many cognate fields of agricultural research.

The Davy Medal is awarded to Professor C. N. Hinshelwood for his work on the kinetics of chemical change, characterized by its pioneering quality and by the varied new lines of research which it has opened up. An experimental investigator of great skill and achievement, Hinshelwood has also enlarged the theory of the subject by able mathematical analyses and descriptions based on the concepts of collisions and of activation energy.

Hinshelwood took a leading part in the early study of homogeneous gaseous reactions. As the result of the examination of a number of bimolecular examples he was able to show, with reason, that these are confined to molecules containing few atoms, and that the actual rate was given by the product of the total collision rate and the probability of a molecule possessing the experimental energy of activation. Unimolecular reactions were found to occur with polyatomic molecules and to show more complex features. In association with Professor Lindemann (now Lord Cherwell), Hinshelwood put forward the mechanism, now accepted, whereby a reaction fundamentally dependent on collisions may nevertheless have unimolecular kinetics. This theory he was able to verify by showing that the rates of such reactions diminish at low pressures and that the kinetics then become bimolecular.

In the field of chain reactions Hinshelwood opened up new lines of advance by studying the thermal reaction between hydrogen and oxygen. Thus he discovered, and offered clear explanations for, the curious phenomenon of "explosion limits," confining explosive reaction, at any fixed temperature, sharply to a particular pressure region. Elaborate studies of the

effects of nitrogen peroxide and other foreign gases on the hydrogen-oxygen reaction brought to light the very great kinetic complexities of an apparently simple type of chemical change. In this work Hinshelwood drew attention to the influence of the container surfaces on chain reactions, and also clarified the confusion of evidence concerning the effects on reaction rates of the intensive drying of gases. He discovered the inhibition of certain gaseous reactions by nitric oxide and interpreted the effect as due to the removal of radicals from, and the suppression of, "chains."

Hinshelwood has also carried out a large number of experiments on heterogeneous reactions and shown that their differences in kinetic behavior can be explained by the application of the concepts of Langmuir.

Throughout all these researches, carried out with the utmost economy and directness, though with full experimental precautions, and interpreted in the most lucid manner, Hinshelwood has never lost sight of the essential complexity of chemical reaction mechanisms. He has always been ready to modify his views in accordance with new experimental evidence and to make the fullest use of the more recent developments of wave-mechanics and of statistical mechanics. Summarized by their author in two well-known treatises, Professor Hinshelwood's distinguished researches furnish abundant ground for the award to him of the Davy Medal.

The Darwin Medal is awarded to Professor D. M. S. Watson, preeminent among paleontologists for his contributions to knowledge of the course of vertebrate evolution. His researches have been concerned mostly with the origin of the land vertebrates, with the fishes most nearly related to them and with the main line of evolution leading to the mammals.

It will not be possible on this occasion to survey Watson's work in all its aspects, and mention must be restricted to some of the major lines of advance which it has opened. His Croonian Lecture, in 1925, summarized the conclusions which he had reached by that date as to the evolution of the Amphibia, demonstrating for the first time the relationship of the Stegocephalia to the Osteolepid fishes.

In addition to tracing the descent of land vertebrates thus from Amphibia back to fishes, Watson followed the line of the evolution of the mammals, through early, primitive reptiles, the Cotylosaurs, to the mammal-like reptiles, in a large series of valuable papers. He related this work on the reptiles to that on the amphibians in a paper on the evolution of the shoulder girdle of the Tetrapoda.

In this work on the fossil vertebrates, in its relation to the course of evolution, Watson has not confined his attention to morphological details, but, with an enterprise remarkable in a paleontologist though characteristic of his outlook, has considered where possible the functional significance of the structures preserved in the rocks; as in the paper in which he considers the mode of action of the shoulder girdle and deduces the nature of the musculature of a group of marine fossil reptiles.

Pursuing his study of mammalian origins, Watson was led to study the most primitive of living mammals, the oviparous Monotremes, and to discover that characters in which their skulls differ from those of other mammals can be regarded as extreme developments of features observed in the skulls of certain fossil, mammal-like reptiles.

Watson's work has continued in full vigor into recent years, and has brought two further contributions of major importance to the study of evolution in the vertebrates. One is concerned with the origin of the frogs from more primitive amphibian types, while the other shows that a group of fishes from the Old Red Sandstone constitute a separate class of vertebrates, equal in rank to and ancestral to the remaining fishes.

Tracing, in this brilliant series of researches, the main stages of the descent of the mammals from their earliest fish-like ancestry, Professor Watson has certainly performed "work of acknowledged distinction in the field in which Charles Darwin himself labored."

The Buchanan Medal is awarded to Sir Wilson Jameson, formerly dean of the London School of Hygiene and Tropical Medicine and since 1940 the chief medical officer to the Ministry of Health and the Board of Education. In both capacities Jameson has shown himself to be a man of stimulating influence and leadership, determined and persistent in his efforts to ensure that advances of medical knowledge in the laboratory, the clinic and the field shall receive prompt application in administrative practice.

Largely to Jameson's vigorous policy is due the hope that active immunization against diphtheria, which has banished the disease from many large communities of North America, will at length find systematic and effective application in this country, where many of the discoveries were made which have rendered it safe and practicable. In the prompt official adoption of methods using modern technical resources, to deal with the recent increase of tuberculosis under war conditions, and in the recognition of adequate and scientifically planned nutrition of the people as a central item of an effective health policy, Jameson's active and enlightened influence can again be discerned.

Of the grounds on which the founder of the Buchanan Medal desired the awards of it to be made, Sir Wilson Jameson's high claim to it is based on "administrative and constructive work" of outstanding merit in the service of hygienic science.

The Hughes Medal is awarded to Professor Enrico Fermi, now of New York. Professor Fermi has made most notable contributions both to theoretical and experimental physics. In the early days of the modern quantum theory he was one of the first theoretical physicists to appreciate the generality of the considerations put forward by Pauli and known as the exclusion principle. This led him to discuss the statistical theory of a perfect gas of particles in equilibrium, obeying this principle, with results which were obtained independently and almost simultaneously by Dirac by similar methods. These results of Fermi and Dirac are of the utmost importance in the modern theory of assemblies of similar particles, such as electrons, protons and neutrons. Following this outstanding personal contribution, Fermi played a great part in building up at Rome a distinguished school of theoretical physics, where he himself made one of the earliest successful attempts to construct a theory of radioactive β-ray change. This theory shows the most profound insight into the theoretical nature of the quantum theory.

His interest in the atomic nucleus led Fermi naturally on to his experimental studies in this field. Immediately after the discovery of the neutron he realized that it provided a new possibility of attack on the nucleus and of stimulating nuclear change by neutron bombardment. This work opened up the fruitful modern field of study concerned with the transformations of nuclei of medium and great atomic number, and led directly to the most exciting transformations of all, the nuclear fission of uranium and thorium.

Professor Fermi's work is characterized throughout by profound insight and great experimental skill. In the fields which he has made his own he is universally acclaimed a leader.

CRISIS IN RUBBER[1]

By JOHN L. COLLYER

PRESIDENT, THE B. F. GOODRICH COMPANY

IT is a pleasure for me to meet with members of the Academy of Political Science. I feel honored and privileged to acquaint you with certain facts pertaining to the all-important question of rubber—natural and man-made.

America is in the grip of a rubber crisis. Our country, which normally uses more than half of all the rubber that is consumed throughout the world, has been shut off by decisive enemy action from sources which formerly produced 90 per cent. of the world's rubber. We are now engaged in a grim race against time. Several hundred thousand tons of new rubber will shortly be urgently needed to manufacture the wide range of war products required by the armed forces of the United Nations and to keep our vital industrial plants and essential transportation functioning.

The crisis that we face resolves itself into a question of whether we can bridge the gap until synthetic rubber manufacturing facilities now under construction within our country's borders are producing the huge quantities of this indispensable material that we will need to win the war.

It seems odd that we should be faced with a crisis in rubber when we stop to consider that rubber originated right next door to us in South America where native or wild rubber trees are situated. The seeds from which the extensive Eastern plantations have sprung were collected in South America in 1876. But by 1900, no more than 10,000 acres have been planted in the East.

The rubber plantations of the world now covering a planted area of approximately 9,000,000 acres have had in 1941 a productive capacity of 1,600,000 tons a year. The world's consumption in 1939 through 1941—a record three-year period—was at the rate of about 1,100,000 tons a year, which left a potential surplus of 50 per cent.

It has been my privilege to have visited the Eastern plantations and to have witnessed rubber manufacturing in most parts of the world, including Germany and Japan. In the course of many visits to Germany during the 1930's, I observed at close range the development of an imposing synthetic rubber industry as the Nazis prepared for war that is now resulting in the greatest death and destruction known to mankind.

During the war of 1914–1918, Germany had an inferior synthetic rubber. Research and development work—started at that time—has been diligently continued and intensified ever since. To-day Germany is probably living at least 75 per cent. on synthetic rubber.

Based on what I learned in Germany and Japan

[1] Read before the Academy of Political Science, New York, November 10, 1942.

and what I had become convinced were the aims and policies of the Nazis and the Japanese militarists, it has since 1937 been my belief that our country could not afford to be without a national insurance policy in terms of rubber. The only alternative was to have our entire national economy continually threatened by the possibility of disruption of the long rubber lifeline to the Far East.

In June, 1940, the stock of rubber in the United States totaled only 168,000 tons. The consumption for the year 1940 was 648,000 tons. The position of about three and a half months' stock was anything but a healthy one for our country and for its economy.

This precarious situation could be corrected only by a two-point program. To make certain that a continuing supply of rubber would be obtainable, new and dependable large-scale sources of rubber had to be created quickly here at home. And meantime, the accumulation of reserve stocks would provide a temporary bank on which to draw until American-made rubber could meet the nation's requirements.

In early June, 1940, knowing that rubber was too vital a material to be left to chance, the B. F. Goodrich Company decided to take action. At a reception in New York nearly two and one-half years ago we introduced for sale to car owners a tire in which American general purpose synthetic rubber replaced natural rubber by more than 50 per cent. This American man-made material was developed by our organization after a research program which was started in 1926, and was even then in 1940 being commercially manufactured in our own plants.

Although we felt and so stated at that time to the Senate Military Affairs Committee that synthetic rubber could be produced on a large scale at a cost of approximately 25 cents a pound, yet we knew that large-scale production of synthetic rubber could not be justified on an economic basis by industry.

Industry had to take a long-range view, remembering that as recently as 1933 crude rubber sold in New York at less than three cents a pound. The 1940 current market price of 20 to 22 cents a pound was artificial, having been brought about by restriction of production of plantation rubber and by war uncertainties. We knew that a cent a pound variation in the price of rubber amounted to approximately $14,000,000 a year based on a consumption of 600,000 tons a year.

Without artificial production restrictions, natural rubber in normal times might have a price advantage of 10 to 15 cents a pound, based on known processes of manufacturing synthetic rubber. This might mean a difference of from $135,000,000 to $200,000,000 a year, or certain disaster to private capital invested in general purpose synthetic rubber plants.

But our company pressed on and sold quite a few of those synthetic rubber tires—in 1940—several thousand of them—to cooperative firms and individuals who were willing to pay a higher-than-market price to help us get an American general purpose synthetic rubber program started. And we did accomplish the two main objectives that we had in view at that time. Our announcement focused the attention of the nation on our critical rubber supply situation, and we believe that we challenged the scientists throughout the country to increased efforts in the whole synthetic rubber field.

Shortly after this step by our company in June, 1940, our government took constructive action. Plans were put into effect for purchasing large reserve stocks of rubber. Under this arrangement the British and Dutch plantations removed the restriction of output bans and produced at capacity.

We had recommended the construction of two or more government financed large-scale synthetic rubber plants by competitive industrial organizations.

But synthetic rubber seemed at the time too revolutionary a step for prompt action on such a scale. A great potential capacity on the other side of the world for growing natural rubber was available, and the cost of creating synthetic rubber plants was admittedly high when figured in dollars.

Two and a half years ago before advocating American standby synthetic rubber plants as the only practical solution, we had given full consideration to other sources of rubber supply.

Our good neighbors, the South American countries, could then provide little more than 5 per cent. of our peacetime requirements for rubber. Six or seven years are required to grow a rubber tree ready for tapping. It was estimated that it would take ten or more years for South America to supply substantially more rubber through increased planting.

Africa was then supplying less than 1 per cent. of the world's rubber, and even if that continent produced sufficient quantities, we would again be depending on another hemisphere.

Guayule, a shrub grown in Mexico and southwestern United States, and supplying less than 1 per cent. of America's consumption, was investigated. Our company has used guayule for more than 30 years and has been the largest consumer in the world of this type of natural rubber. Guayule is a serviceable rubber, but with the seeds then available, the time of growing would be too long for increased planting to meet the emergency that faced us. 75,000 acres of guayule are being planted by the United States government, but in all probability these will not be harvested until 1945, when 50,000 or more tons should be obtained.

But none of these sources of rubber was in 1940 or

in 1942 prepared to supply our emergency demands. Synthetic rubber, a product of American science, was then and is to-day our hope.

It was not until the bombs fell on Pearl Harbor that a large-scale synthetic rubber program was announced by our government—400,000 tons a year—authorized in January, 1942. Unfortunately at that time no over-all planning of structural materials, equipment and raw materials had been carried out.

Hindsight is always easy, and it is readily understandable why the vast majority of people, even some of whom had spent a lifetime in rubber, did not foresee during 1940 and 1941 the possibility of the rapid-chain of events which have since deprived us of 90 per cent. of our rubber supply.

But that is water over the dam. It is not the past but the future which will determine our fate.

The January, 1942, authorization of a total capacity of 400,000 tons a year of butadiene synthetic rubber just mentioned, estimated to cost $400,000,000, has since been increased and the present program is made up of plants designed to produce 705,000 tons of synthetic rubber of the butadiene-styrene type, 132,000 tons of butyl rubber and 40,000 tons of neoprene, or a total of approximately 900,000 tons a year, with an estimated plant cost of $700,000,000. In addition, Canada is carrying out a program for creating a capacity of 40,000 tons a year of the butadiene type synthetic, and I believe that Russia has been producing as much as 50,000 tons a year.

Our company has recommended that we refer to the butadiene type rubber as AA (Pronounced—Double A), an abbreviation for All-American. We object strenuously to calling this new rubber by the German name Buna. The AA rubber, as we term it, will be produced in plants designed, constructed and operated by American engineers and will be made by a process incorporating the best features of the All-American research and development of the companies participating in the program.

Undoubtedly you would like to know something of how AA rubber is produced. The basic raw materials are three parts of butadiene and one part of styrene. Butadiene is a gas which can be made either by cracking petroleum, or by removing hydrogen from butylene, a by-product in the manufacture of high octane gasoline, or by catalytic conversion from alcohol. No matter from what basic raw material it is prepared, the resulting butadiene when properly purified is the same. The other raw material styrene can be most conveniently manufactured from the aromatic hydrocarbon benzene obtained from coal tar and ethylene, a gas which occurs as a by-product in most petroleum refineries.

The responsibility for the construction and operation of the plants to produce the butadiene and styrene to be used in the manufacture of All-American synthetic rubber has been delegated to the petroleum and chemical industries.

To the rubber companies has been given the task of building the polymerization or synthetic rubber plants and of producing AA rubber from raw materials supplied to them mainly by the chemical and petroleum industries.

In the polymerization process, butadiene which has been liquefied by compression and cooling is mixed with styrene, soapy water and several minor "salt and pepper" ingredients. This mixture is then heated and stirred under pressure, whereupon the molecules of butadiene and styrene polymerize or join together to form an emulsion of synthetic rubber which is quite similar in appearance to the latex obtained from rubber-producing trees. From here on the process of obtaining sheeted rubber is like that used for natural rubber.

Already much that is good and several things that are bad have been discovered about the usefulness of this new rubber. Test tires whose rubber content is 99.84 per cent. of this synthetic rubber are running on the highways in various parts of the country. Passenger car tires and small-size truck tires give excellent service. However, when we come to the manufacture of large-size truck and bus tires urgently needed for military use, several difficult problems arise due to the fact that synthetic rubber tires in service generate more heat than natural rubber tires, thus causing an earlier failure. We are now hard at work on this problem and we are confident that it can and will be solved as we gain more experience in the field.

Even now, almost all essential rubber articles can be made from AA rubber including hundreds of important rubber products used by the armed forces of our nation.

When will the production of this man-made rubber fully meet our necessary requirements? Certainly not until 1944. Compared to our consumption of 765,000 tons of rubber last year, we shall produce about 32,000 tons of American-made rubber this year, practically all from privately financed plants.

In 1943 the government plants will come into big production and estimates for all types range from 300,000 to 500,000 tons, and in 1944, from 700,000 to 1,000,000 tons.

This tremendous program for man-made rubber in quantities sufficient to meet our vital requirements must be fulfilled or the nation will, in a matter of months, be confronted with a critical situation highly dangerous to our military forces and our whole civilian economy. We must have rubber to win this war.

Late 1943 will see our stocks of rubber, and those of our Allies, near exhaustion.

It is imperative that we have the utmost speed in building and equipping the giant plants and in the actual production and use of man-made rubber. Every day lost now means irreplaceable loss of rubber, for we are living on our fat. And our fat is rapidly disappearing.

The construction of the government synthetic rubber plants is one of the most highly technical and complicated engineering jobs of all time.

Several hundred thousand tons of critical materials will be used. These materials necessary for the construction of the plants and equipment must be made available promptly or there will be further serious delays in completion of the production facilities so urgently needed.

Thousands of skilled mechanics, pipe fitters, electricians and construction workers are required, and I feel that unusual measures will be necessary to make them available when needed.

We must have enough rubber in time and not too much too late.

Mr. Jeffers, our rubber administrator, and his organization are working day and night on every phase of the problem and particularly on structural materials and man-power.

I have said that the real crisis in rubber will come next year. How well we shall meet and pass the 1943 crisis will depend mainly upon our ability to conserve rubber and to produce synthetic rubber. This statement of fact is made clear in the constructive and timely Baruch committee report which I feel would provide extremely interesting reading to members of the Academy of Political Science.

The Baruch committee, while critical of the handling of the rubber problem, did report encouraging progress in synthetic rubber, as for example the following, which I quote:

> Our committee is convinced that the government's present program is technically sound. From this time on, the important thing is to get on with it without delay. . . .
>
> It is our firm conclusion that present processes for manufacturing synthetic rubber and raw materials required must not at this late date be changed unless new processes can be shown beyond peradventure to have such advantages over these now employed that more rubber would be obtained in the ensuing months than would otherwise be the case. We have found no such process in the course of our investigations.

I think it is important that we consider another statement made in the Baruch report. Again I quote:

> Probably the most interesting and satisfying part of our study is the confidence we have acquired in the men from the industry who have the plans in hand and who are satisfied they can lick the problem in the given time. Their competence and experience, their resourcefulness and ingenuity, are the best guarantees that we can do so.

The stark fact that lack of rubber could cost us this war is clearly stated and fully explained in this enlightening report which should be a constant reminder to us that we must never again become wholly dependent on distant sources of rubber supply.

Fortunately, thanks to the farsightedness of our government, we had, when the Eastern plantations were captured, approximately 600,000 tons of rubber, which is a normal year's supply for our country. I mentioned that in June of 1940 this total was only 168,000 tons. Our stocks of crude rubber and that contained in finished products, as well as our stocks of scrap rubber and reclaimed rubber, must bridge the gap until synthetic rubber becomes adequate for military and other essential needs.

Rubber in tires on cars now on the nation's highways actually constitutes the largest stockpile of rubber in this country—approximately 1,200,000 tons—or nearly double our total crude stocks at the beginning of this year.

The Baruch committee in recommending mileage rationing recognized the absolute necessity to our war effort of keeping all cars in operation for essential driving.

We in B. F. Goodrich feel now as we have for the last two years that all cars are essential cars, but that all driving is not essential driving. The government now has a program to convert that basic fact into a nation-wide conservation habit.

The purpose of the rationing program which is scheduled to begin nationally November 22 is to insure on a fair and just basis the operation of all passenger cars for essential driving with a minimum consumption of rubber, reclaimed rubber and rubber substitutes.

I am confident that we shall all respond with good spirit to the requirements of the mileage rationing program until synthetic rubber becomes available in quantity for civilian use.

I am informed that the 35-mile speed law now a national regulation is being splendidly observed. Sales of gasoline in unrationed areas have already sharply decreased, reflecting a reduction in mileage that is startling only to those who underestimated American willingness to make personal sacrifices if they will help to win this war. That to me is most heartening. It proves that the American people will respond even to bad news if they know fully what is required of them.

This war, more than any other war in history, is a conflict of materials and resources, as well as a battle of men. Rubber is one of the strong and versatile

threads that we must weave through the fabric of our industrial production and transportation systems to supply and maintain our modern armies and navies.

By contributing to the solution of America's rubber crisis, each one of us will do a wartime job of No. 1 importance. Any circumstance or any policy that prevents the effective functioning of our home-front industries and essential civilian transportation can be just as disastrous to our war effort as a defeat in battle.

Our gallant fighting men know that courage alone is a thin weapon against Axis planes and tanks. They look squarely to our country to deliver in time and where needed superior weapons and equipment—weapons and equipment which require thousands of tons of rubber.

The design, construction and capacity operation of our many giant synthetic rubber plants—in time—will be one of the greatest industrial achievements of all time. Conservation of rubber must bridge the gap until our rubber problem has been solved.

Industry is supremely conscious of its part in this grave responsibility, and the American people are now fully conscious of their own important role.

SCIENTIFIC EVENTS

RECENT DEATHS

DR. GARY N. CALKINS, emeritus professor of protozoology, of Columbia University, died on January 4, in his seventy-fourth year.

DR. DAVID M. LICHTY, who retired in 1932 from an associate professorship of chemistry at the University of Michigan, died on December 24, at the age of eighty years.

THE death is announced of Alfred Nelson Finn, for many years chief of the department of optical glass of the National Bureau of Standards, at the age of sixty years.

DR. JAMES EDMUND IVES, until his retirement in 1936 senior physicist of the U. S. Public Health Service, died on January 1, of injuries received when struck by a street car on New Year's Eve. He was seventy years old.

DR. ANDREW H. PALMER, who from 1914 to 1924 was a meteorologist of the U. S. Weather Bureau and was later superintendent of crops and weather insurance of the Aetna Affiliated Companies, San Francisco, died on December 26, at the age of fifty-six years.

DR. PURNENDU NATH CHAKRAVORTY, a native of India, research chemist with the Upjohn Company and formerly associated with the department of chemistry at Princeton University, was killed in a railroad crossing accident on December 23. He was thirty-seven years old.

HARVEY L. WESTOVER, senior agronomist in charge of forage crop investigations in the Bureau of Plant Industry of the U. S. Department of Agriculture, known for his work with alfalfa, died on January 2, at the age of sixty-three years.

FREDERICK DIXON CHESTER, chief chemist of the Mimex Company, Long Island City, died on January 1, at the age of eighty-one years.

DR. E. J. ALLEN, from 1895 to 1936 secretary of the Marine Biological Association of the United Kingdom and director of Plymouth Laboratory, died on December 7 at the age of seventy-six years. The Linnean Gold Medal was awarded to him in 1926; the Darwin Medal of the Royal Society in 1936, and the Agassiz Medal for Oceanography of the National Academy of Sciences in 1936.

AMERICAN LIBRARIES AND FOREIGN PERIODICALS

IT is reported by Harold Lancour, librarian of Cooper Union, chairman of the Engineering School Libraries Section of the Association of College and Reference Libraries, that American librarians are tracking down hundreds of publications which seep into this country from Axis-dominated areas and which contain valuable technical and scientific data eagerly sought by scientific workers.

Through an investigation in progress since last August, the section has already ascertained that more than 800 periodicals published in Germany and Japan as well as in countries occupied by the Axis are reaching the United States sporadically and by devious channels, despite mailing restrictions and accidents in transit.

Many foreign periodicals legally mailed go down with torpedoed ships or are held up to make room for more vital cargo. Others, not permitted to go outside the country which publishes them, are smuggled out by refugees; some pass the censor in limited numbers; still others reach Americans by mail from scientific men in conquered lands which do not permit bulk mailings but which allow individuals to send out one or two periodicals.

Spotty holdings of foreign periodicals by libraries throughout the country, with many issues and titles missing completely since 1939, has created a demand for a master file through which every library will be able to find quickly any issue of any foreign peri-

odical known to be available in some library in the country. By referring to an over-all list showing which libraries are in possession of certain issues of the various periodicals, it will be possible to obtain urgently needed material by borrowing or by photostatic reproduction of the desired material.

Important government research projects, such as the experimental production of a substitute for hemp which is to be undertaken jointly during the coming year by the U. S. Department of Agriculture and Iowa State College, are dependent to a considerable degree upon war issues of foreign journals.

Almost daily calls are received by libraries for issues of foreign periodicals published since the war's beginning on the prevention of disease among human beings and animals, as well as publications shedding light on food and nutrition problems.

Mr. Lancour points out that "we are pledged to secrecy regarding the nature of much of the research work in progress. Research in wartime is accelerated at a rate it would never reach in peace time, and the government is spending money, energy and time to an unprecedented extent on technical and scientific investigations. The importance of intensive research in wartime is amply borne out by Germany, who would be lost without her 'ersatz' products—largely made possible by chemical research."

So important is the preparation and maintenance of a master file of current technical and scientific literature published abroad and obtainable in this country, that the Library of Congress has recently taken over the project begun by the Engineering School Libraries Section, which embraced only technological and engineering publications. The Library of Congress, it is explained, will continue the investigation and broaden the list to include publications devoted to agriculture, medicine and other scientific and technical fields.

Hundreds of libraries throughout the United States are aiding investigators in establishing the whereabouts of missing issues and titles. Each library will report on its own holdings, and make additions to the list of titles circulated to them for checking. The final list, which will also include periodicals available only on microfilm or photostats, will be kept up to date through regular checkup reports by participating libraries. All libraries on the mailing list of the Library of Congress will receive a copy of the up-to-date list at intervals for their own use in filling requests for foreign publications.

THE SCHOOL OF DENTAL AND ORAL SURGERY OF COLUMBIA UNIVERSITY

IN his annual report Dr. Willard C. Rappleye, dean of the School of Medicine of Columbia University, states that the School of Dental and Oral Surgery may continue in the post-war period the accelerated program by which students graduate in three years instead of four, provided that it is possible to give financial assistance, and that necessary adjustments can be made in state laws governing licensure for practice.

He points out that it seems logical that loans and scholarships for these men and women would be a good investment, both from the standpoint of the individual student and the community. The inauguration of the accelerated program presents a very serious problem to students who have been dependent upon funds earned during the summer period. He writes: "We are extremely grateful to the W. K. Kellogg Foundation for a grant of $10,000 for a special scholarship and loan fund for our students. This gift will make possible the completion of the professional education of many of our students who might otherwise have been obliged to abandon their dental course."

An attempt is being made to modify the instruction somewhat to compensate for the decreased efficiency of students working during the summer months. More conferences will be held, and an extensive use will be made of kodachrome microphotographs of the slides of the tissues and organs. The report points out further that

> the war has had a decided effect upon the operation of the Dental School. Nine members of the staff have been granted leave of absence to serve with the Army or Navy. The fact that dental students have been able to apply for reserve commissions as ensigns in the Navy and as second lieutenants in the Medical Administrative Corps of the Army has assisted in reducing the tremendous amount of clerical work previously required in securing deferment of dental students for periods of six months from the local draft boards.
>
> However, the fact that the Army, the Navy and the Marines are competing with each other in advertising for young men to enlist is going to deplete the ranks from which dental students have been drawn and result in a less desirable selection of students for the schools and a wasteful use of the nation's manpower. Of the forty-six male members of the graduating class all but seven are commissioned in the Army or Navy, and twenty-one have been called to active service.
>
> The war has also made itself felt in the increased cost of supplies and equipment for the operation of the school clinic and in the inability to secure many items at any price.
>
> The department of physiology has been devoting much of its investigative work to the study of traumatic shock, under contract with the Office of Scientific Research and Development. Additional support for this and related studies has been received from the Josiah Macy, Jr., Foundation.

In the division of oral histology, Professors Charles F. Bodecker and William Lefkowitz have shown that structural changes occur in the dentin after the eruption of the teeth. These changes have been called "protective metamorphosis" because they offer an added resistance to decay. Dr. Lefkowitz has demonstrated that protective metamorphosis begins in the crowns of the teeth five years after their eruption and progresses to the root. These changes show that vital activity occurs in the dentin long after this tissue is fully formed.

DIVISION FOR EMERGENCY TRAINING AT THE UNIVERSITY OF MICHIGAN

SPECIAL training programs for all students preparing for military and civilian service to the country which do not fall within the scope of the fourteen existing schools and colleges of the University of Michigan will be organized and directed by a new Division for Emergency Training, established by the Board of Regents at their December meeting. The division will not take over the functions of the older schools and colleges or attempt to duplicate their work, but will supplement their activities and act in cooperation with them.

The teaching staff will be recruited in so far as possible from the present faculties, many of whose members can be loaned by their respective schools and colleges in view of reduced teaching obligations resulting from the draft of men of college age and the calling up of college reservists. Associate Professor Marvin L. Niehuss, of the Michigan Law School, was named coordinator of emergency training and will act as executive head of the division.

The regents directed the new division to plan and announce training programs relating to the war effort for the following classes of students:

(1) Those high-school graduates who wish to receive special preparation prior to their induction in the armed service.

(2) Those students now enrolled in the university who wish kinds of preparation for special war or supporting civilian service not available in the schools and colleges in which they are enrolled.

(3) Adults, including those who are not high-school graduates, but who are qualified to take courses offered in the division.

(4) Officers and enlisted men and women of the armed forces who may be sent to the university for prescribed training not available in the other schools and colleges.

(5) Veterans of the present war who wish specialized training not provided in the existing schools and colleges.

(6) Such other selected individuals not eligible for admission to other schools and colleges of the university for whom it is possible and expedient to provide programs of instruction that would increase their efficiency in the armed forces or in supporting civilian services.

Establishment of the division is especially important in the light of the newly announced plans of the Army and Navy which contemplate the use of college and university facilities for training officers and specialists for various branches of military service and in view of the demand for specialized training of personnel for jobs in the supporting civilian economy. Training in both these categories may cut across the lines separating the functions of the existing university units and call for a centralizing agency which can mobilize all university facilities in the emergency. The division will be able to admit students for special war training who do not meet entrance requirements in the older teaching units, thus eliminating the necessity of changing these requirements and disrupting the existing instructional programs which are essential for other groups of students.

BEQUEST FOR THE ENDOWMENT OF THE TECHNICAL INSTITUTE OF NORTHWESTERN UNIVERSITY

A BEQUEST of more than $20,000,000 is made to Northwestern University by the will of Walter P. Murphy, manufacturer of railway supplies, who died on December 16. Dr. Franklyn B. Snyder, president of the university, points out that this is the largest bequest ever made to higher education by a citizen of Chicago, and is probably the largest in the nation since 1924, when James B. Duke bequeathed $40,000,000 to Trinity College (now Duke University).

Notification of the bequest came to President Snyder from the executors of the Walter P. Murphy estate, who informed him that Northwestern University will receive the entire estate after payment of bequests to relatives and friends and that the value of the gift was estimated to be "in excess of twenty million dollars."

Mr. Murphy specified that the fund should be used to develop, maintain and operate the Technological Institute of Northwestern University, which was founded in 1939 with a gift of $6,735,000 from the Walter P. Murphy Foundation. Beyond this restriction, no limitation was placed on the use of the bequest, leaving to the board of trustees of the university the final decision as to future management.

Mr. Murphy expressed a desire that as much as possible of the principal should be held intact and used for endowment of the institute. At the same time he empowered the trustees to spend portions of the principal from time to time, and all or any part of the annual income, for additional buildings, equipment, professorships, scholarships, books, research and such other purposes as the trustees think necessary to the proper operation of the institute. He also specified that the institute, as a part of its operations, may give instruction in science to other than engineering students of the university.

The present bequest is Mr. Murphy's fourth benefaction to the university. He made two gifts in 1923, one of $5,000 to the College of Liberal Arts and one of $10,000 to the School of Commerce. In 1939, through the Walter P. Murphy Foundation, he gave $6,735,000 to erect and equip the new building of the institute.

Completed in the fall of 1941 at a cost of $5,000,000, the Lannon stone building was dedicated on June 15 and 16, 1942, with a series of conferences in which educational and industrial leaders of the nation participated. It houses the departments of civil, chemical, mechanical and electrical engineering of the institute, and the departments of physics and chemistry of the university.

The institute is operated on the "work-study" plan in which student engineers alternate three months of study on the campus with equal periods of work in cooperating industries. It began operations in the fall of 1939, before the present building was erected, and to-day has an enrolment of 750 full-time students. Approximately 95 industrial organizations in thirteen states cooperate with the institute in its work-study program.

Built to accommodate about 1,000 engineering students, the institute is to-day training 4,500 men and women to acquire technical skills essential to winning the war. In addition to training engineers, it is carrying on the following vital activities: a Naval Radio Operators' School; an Army Signal Corps Officers' Training School; a pilot training program for the Navy; evening courses to train workers for war industries; and a vast program of confidential war research for the government.

Mr. Murphy has consistently avoided any personal recognition of his generosity in founding the institute, rejecting on several occasions the suggestion that the institute be named after him. In the great halls of engineering and science that he established, there is no mark of recognition of him except one—a portrait that he permitted to be hung in the faculty lounge on the top floor of the north tower.

SCIENTIFIC NOTES AND NEWS

DR. JAMES B. CONANT, president of Harvard University, formerly Sheldon Emery professor of organic chemistry, will receive the annual award of the New York Academy of Public Education for distinguished service to education. The presentation will be made at the annual dinner meeting of the academy, which will be held at the Hotel Waldorf-Astoria on February 18. Dr. Conant will be the speaker at the dinner. His subject will be "The Relation of Science to Society in the Post-War World."

SIR JOHN RUSSELL will retire on September 30, under the age limit, from the directorship of the Rothamsted Experimental Station. Sir John succeeded Sir Daniel Hall in 1912. The station reaches its hundredth year in 1943, and but for the war the centenary would have been the occasion of an international celebration.

IN recognition of his distinguished services as rector of the Imperial College of Science and Technology from 1929 to 1942, Sir Henry T. Tizard, president of Magdalen College, Oxford, has been elected to an Imperial College fellowship.

THE honorary degree of doctor of science was conferred by the Drexel Institute of Technology, Philadelphia, on December 17 on William L. Batt, chairman of the Engineering Industrial Division of the National Research Council, who gave the commencement address at the Founder's Day and commencement exercises of the institute.

AT the fiftieth anniversary commencement of the New Jersey College of Pharmacy in Newark on January 6, Rutgers University conferred the honorary degree of doctor of science on George D. Beal, assistant director of Mellon Institute of Pittsburgh. According to the citation the action was taken "to pay appropriate tribute to Dr. Beal for his contributions to scientific progress in general and to pharmaceutical chemistry in particular."

THE *Journal* of the American Medical Association reports that Dr. John L. Myers, Kansas City, was presented with a wrist watch during the meeting of the American Academy of Ophthalmology and Oto-Laryngology, in appreciation of his sixteen years' service as a section secretary of the academy.

DR. WILLIAM A. PROUT has been appointed acting director of the School of Pharmacy of the Medical College of the State of South Carolina, Charleston. He will continue as professor of pharmacy.

Chemical and Engineering News reports that R. Bowling Barnes, of the Stamford Research Laboratories of the American Cyanamid Company, has been elected first president of the National Conference of Electron Microscopy formed by leading workers in this field meeting at the National Chemical Exposition in November. Albert F. Prebus, of the Ohio State University, was elected vice-president, and Charles Banca, of the RCA Manufacturing Company, Camden, N. J., secretary-treasurer. Dr. V. K. Zworykin, of the Radio Corporation of America, and Dr. O. S. Duffendach, of the University of Michigan, were

elected to serve with the officers of the conference as its directors. Dr. G. L. Clark, of the University of Illinois, presided at the formation meeting. Dr. Clark, L. A. Matheson, Dow Chemical Company, and Dr. Duffendach constituted the committee which called and arranged the initial conference.

DR. JAMES G. HORSFALL, head of the department of botany and plant pathology of the Connecticut Agricultural Experiment Station, a member of the "plant protection committee" of the National Research Council, has been appointed chairman of the "fungicide sub-committee" of the American Phytopathological Society.

DR. ALBERT W. DAVISON, William Weightman Walker professor of chemical engineering and head of the department at the Rensselaer Polytechnic Institute, has been appointed scientific director of the research laboratories at Newark, Ohio, of the Owens-Corning Fiberglas Corporation. He is succeeded at the institute by Dr. Louis S. Coonley, associate professor of chemical engineering.

THE *Journal* of the American Medical Association states that Dr. Bert E. Caldwell, for fifteen years executive secretary of the American Hospital Association, has resigned effective on the appointment of a successor. Dr. Caldwell has been editor, since its establishment seven years ago, of *Hospitals*, the journal of the association.

RICHARD A. MCLEAN, assistant curator of mollusks at the Academy of Natural Sciences of Philadelphia, has been commissioned an ensign in the Navy and is assigned to Fort Schuyler, N. Y.

DR. DONALD FAIRBAIRN has been appointed post-doctorate fellow in biochemistry under a Hoffmann-La Roche grant in the University of Pittsburgh.

HAROLD W. COLES, of the Mellon Institute, has become associated with the research staff of the Bausch & Lomb Optical Company, Rochester, N. Y. He has been placed in charge of the new department of organic chemistry.

DR. ENRIQUE BELTRÁN, professor of zoology at the University of Mexico and head of the Division of Protozoology of the Institute of Public Health and Tropical Diseases, has been invited by the American Government to make a visiting tour to the United States. Professor Beltrán, who is also permanent secretary of the Mexican Society of Natural History, plans to visit various laboratories, museums and learned institutions at Washington, Baltimore, Philadelphia, New York, Chicago, Memphis and New Orleans.

A DINNER meeting of the Midwest Section, American Association of Cereal Chemists, will be held on January 11 at 29 South LaSalle Street, Chicago. At that time Dr. Robert D. Coghill, chief of the fermentation division, Northern Regional Research Laboratory of the U. S. Department of Agriculture, Peoria, Ill., will be the speaker. Dr. Coghill will present the latest authoritative information on fermentation as a tool in the utilization of farm products, based on a recent paper he gave before the American Association for the Advancement of Science. The meeting will be shared by cereal chemists and brewing chemists.

THE Naval Ordnance Laboratory at the Navy Yard, Washington, D. C., is a research and development agency of the Bureau of Ordnance, concerned with the design of new types of naval mines, depth charges, torpedoes, aerial bombs and other ordnance equipment, including measures for the protection of ships against mines. This laboratory is urgently in need of additional technical personnel. Physicists and electrical engineers with electronics experience are required. The laboratory also needs mechanical engineers familiar with the design of small mechanical movements or mechanisms. Several openings are available in technical report writing and editing.

THE New York meeting of the American Physical Society, originally announced for December 28, 29 and 30, will be held on January 22 and 23 at Columbia University. The meeting normally held in February will be omitted. However, a meeting will take place toward the end of April in a city (not Washington) later to be designated.

"THE Role of the Teacher and the Scientist in Civilian Defense" will be the subject of a discussion to be held by the New York branch of the American Association of Scientific Workers on Wednesday, January 13, at 8:15 P.M. Dr. Harry A. Charipper, chairman of the department of biology, Washington Square College of Arts and Science, and member of the Central Training Staff, Air Warden Service, Police Department, New York City, will be the main speaker. Three British civilian defense films will be shown, describing the detection and identification of poison gases, the incendiary bombing of London and the Air Raid Precaution Services of London and Moscow. The meeting will be held in Room 703, Main Building, Washington Square College of Arts and Science, 100 Washington Square East, New York City.

THE Arnold Arboretum of Harvard University has recently received a gift of $50,000 from Miss Louisa W. Case, of Weston, Mass., together with her residence, barns, greenhouses and fifty-nine acres of land in Weston, to be utilized for the general purposes of the arboretum. The real estate is assessed at $84,000. The gift is a memorial to James B. Case, the father of Miss Case. Several hundred young hybrid oriental

crab apples and cherries have already been planted by the arboretum staff on the Case estate.

THE Army-Navy "E" Award was presented on December 29 by Major General Benjamin W. Chidlaw, assistant chief of staff of the Engineering and Material Division of the U. S. Army Air Forces, to the Nylon Research Laboratory and Pilot Plant of the du Pont Company. The award of lapel pins to employees was made by Captain C. A. Bonvillian, U.S.N., of the Industrial Department, Philadelphia Navy Yard. This will be the sixteenth official presentation among seventeen "E" awards which have been made to plants of E. I. du Pont de Nemours and Company.

THE council of the British National Farmers' Union has decided to ask the Ministry of Agriculture to send a representative to the United States, New Zealand, and any other countries where drying of foodstuffs is being carried out on a commercial scale in order to secure full information regarding processes of dehydration.

The Times, London, states that plans for the world after the war were discused at two meetings in London on November 20. Allied physicians of the nations who spoke on medical aid to stricken Europe agreed that steps would have to be taken by instruction and propaganda, possibly through broadcasting, to restore suitable standards of nutrition and to prevent an increase in infection in the occupied territories. The physicians who work as a technical advisory committee under the Allied Post-war Requirements Bureau have also agreed upon a basic list of drugs which will be needed in the occupied territories as they are liberated. At the second meeting representatives of allied departments met at the Board of Trade to discuss questions relating to the post-war economic structure. Mr. Harcourt Johnstone, parliamentary secretary to the Department of Overseas Trade, presided.

DISCUSSION

FIGMENTS OF THE IMAGINATION

MOST residents of the United States who have not had tropical experience look on the tropics with dread because of the "snake-infested jungles." This idea has been built up over a long period of time by highly imaginative travellers who apparently feel that they must impress their audiences with the great dangers they encountered and overcame in their arduous explorations of these terrible regions; the curious thing is that they always live to tell their harrowing experiences with these deadly reptiles. They are always encouraged to expand on the subject by the enterprising newspaper reporter and popular writers who must make a story. The result is that the average individual, visiting the tropics for the first time, expects to see poisonous reptiles behind every tree and bush and even hanging from the branches ready to do their deadly work. These traveller's tales, told over and over again, and losing nothing in the telling, have resulted in establishing an ingrained fear of the tropics on the part of our general public, and this in turn proves to be distinct dis-service to the thousands of our soldiers and marines who, of necessity, must now serve in one part of the tropics or another.

As a matter of fact in no part of the Old World tropics with which I am personally familiar are poisonous snakes either common or numerous, and I speak on the basis of twenty-two years actual experience. Much of this time was spent in the forests and jungles in all parts of the Philippines, with some experience in the Malay Peninsula, Java, and Borneo. On many trips lasting from two to six weeks each, on some of them being constantly in the forests and jungles, and seeing no other persons than the members of my own party, I have never actually seen a single snake, poisonous or otherwise; on other trips one might average seeing perhaps one snake in a week. The snakes are there, but if one is interested in snakes one must know where, how, and when to look for them. They are mostly timid and disappear at the slightest disturbance. Interested in checking on my own personal experiences I asked Dr. Frans Verdoorn, who spent two years prosecuting intensive field work in botany in the Malay Peninsula, Sumatra and Java, and he reports that he almost never saw a snake in the jungle. I asked Colonel Arthur S. Fisher, who was evacuated from Corregidor shortly before that fortress fell to the Japanese, and who for three months was in active service on Bataan Peninsula after the fall of Manila, and he stated that he saw exactly four snakes in three months, and two of these were brought to him by soldiers. My personal experiences in the American tropics are limited to six trips to Cuba; and I never saw a snake in Cuba. Professor Oakes Ames informs me that in his trips to parts of Mexico, Yucatan, Panama, Honduras, Costa Rica, Colombia, Venezuela, Ecuador, and Brazil, he saw a total of three snakes.

As a matter of fact there is infinitely less chance of an individual operating in the tropical forests and jungles being bitten by a poisonous snake than there is in any part of the United States where the water moccasin and the rattlesnake occur. On any pleasant

day in summer, on a day's trip through the fields and woods, even in New England, one will actually see many more snakes than one would encounter in any part of the tropics with which I am familiar, if one excepts the seasonal sea snakes. These reptiles, at certain seasons, may at times be seen literally by the thousands, particularly when they leave the sea to breed. All or most of them are poisonous, but their mouth parts are so constructed that they can not possibly strike a flat surface (they might be able to strike a small surface like one's finger). It is rather amusing to note how indifferent the native fishermen are when they happen to draw a net and bring in large numbers of them; they kick them about with their bare feet and nonchalantly pick them up and throw them back into the sea—so much for poisonous snakes.

Another fetish is the terrible poisonous plants that one must guard against in the tropics. I suppose that here our imaginations have been fed by the marvellous tales of the deadly upas tree, and in modern times, by the terrible man-eating tree of Madagascar. Incidentally some years ago, an American soldier who couldn't let the Philippines be outdone by Madagascar, published a lurid Sunday supplement story about one he saw in the Philippines; just another case of *horribilia philippinensia*. Here again, as far as contact poisons are concerned, there is infinitely less chance of one's being poisoned in any part of the Old World tropics than there is in any part of the United States where the poison ivy, poison oak, and poison sumac occur. In the jungles of the Malay Peninsula, Borneo, New Guinea, or any other part of the Malayan region, one is infinitely safer, as far as dangerous plant species are concerned, than one would be in the suburbs of Boston or in the Berkeley hills in California, or even within the New York Botanical Garden or the Arnold Arboretum where poison ivy occurs. It is interesting to note that without exception, and no matter where they occur, those plant species that produce eruptions simulating *Rhus* poisoning, all belong in several genera of the same natural family, the Anacardiaceae. Thus in the Malay Peninsula, Sumatra, Java, and Borneo, there are various forest trees collectively known as *rengas,* belonging in such genera as *Gluta, Melanorrhoea, Melanochyla, Semecarpus,* and *Swintonia,* that have a distinctly poisonous sap; some of these genera have representatives in the Philippines and in New Guinea. The sap of several species of *Mangifera,* such as *M. caesia* (bingai), *M. odorata* (kwini), *M. kemanga* (kemang), *M. foetida* (bachang), cause bad skin eruptions; rarely one will note cases where individuals may be allergic to the common mango (*Mangifera indica*). Several of these "poisonous" species of *Mangifera* are actually cultivated for their edible fruits and occur about residences and in towns, but the local residents are not inconvenienced by them. Even the resinous sap in the pericarp of the fruit of the common cashew nut (*Anacardium*) is irritating. The remedy for any eruptions caused by contact with the sap of these species is the same as that indicated for poison ivy infections. In passing, it is interesting to note that while the sap of the trunk or branches, or occasionally the leaves may be irritating, yet in several of the genera mentioned above the fruits may be eaten with impunity (*Mangifera, Semecarpus,* and some species of *Gluta*).

Aside from the contact poisons among the representatives of the Anacardiaceae mentioned above, mostly large forest trees, and not likely to cause any trouble except if one actually cuts them down, all other plants with which one might come in contact in Malaysia and in Polynesia may be classed as minor nuisances. These are the few species that bear stinging hairs. The worst of these are the tree nettles (*Laportea*) of which about 100 species have been described. Contact with the hair-bearing parts instantly produces the sensation of having touched a piece of very hot iron. While the sting from these hairs (apparently caused by formic acid) is intense, it is not normally dangerous, for not even a cub Boy Scout would touch a plant a second time. Fortunately these shrubs or small trees are not common, and certainly none of them is to be feared. *Laportea* is merely a somewhat exaggerated stinging nettle.

The remaining category are those species, few in number, widely scattered, and often very rare, where the inflorescences, or the fruits, or both, may be supplied with stiff bristle-like stinging hairs, their tips supplied with minute retrorse barbs (*Mucuna*). These hairs are easily detached but are never poisonous, and are merely mechanical irritants. They are never dangerous, and again not even a cub Boy Scout, once stung, would touch a plant a second time. And we should remember that cowhage (*Mucuna*) hairs were formerly used as a remedy for tapeworm, the hairs being mixed with molasses and swallowed. The theory back of this remedy, I suppose, was that the tissues of the tapeworm are softer than the lining of the human stomach and would thus attract the stinging hairs which in turn would kill the tapeworm.

E. D. MERRILL

MORE ABOUT "DEFORMATION OF ROCK STRATA BY EXPLOSIONS"

MR. NETTLETON[1] is probably correct in rejecting the idea that the gravity anomaly found in Sierra Madera

[1] L. L. Nettleton, SCIENCE, December 4, 1942, Vol. 96, No. 2501, page 515; J. D. Boon and C. C. Albritton, Jr., SCIENCE, October 30, 1942, Vol. 96, No. 2496, pages 402-403.

is due to buried meteoritic material. Not that meteorites large enough to produce this anomaly never fall upon the earth, but rather that giant meteorites are largely back-fired from their craters. Moulton[2] has calculated that a swiftly moving meteorite may produce a pressure of fifteen million atmospheres at the time of its impact. No one knows how earth rocks would be affected by fifteen million atmospheres of pressure, for this is far beyond our experiments and in fact beyond our comprehension. However, it seems quite certain that rocks of all kinds would be greatly compressed by this amount of pressure. If this be true a terrific explosive rebound must follow the impact, lifting strata far above their original level. This uplift of the deeper strata might well produce a gravitational anomaly. Rebounds of elastic solids is not a matter of speculation. It seems to be characteristic of all great impacts that are not able to break through the material that receives the impact.

Can any one suggest how structural bilateral symmetry with overtilted beds on one side of the structure can be produced by volcanic explosions that come solely from within the earth? It is this kind of symmetry that is found in Meteor Crater, Sierra Madera, Flynn Creek structure and a number of the cryptovolcanic structures. Oblique meteorite impacts offer a satisfactory explanation of this symmetry.

J. D. BOON[3]

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[2] F. R. Moulton, "Astronomy," 1931, p. 305.

VITAMIN C (ASCORBIC ACID) CONTENT OF THE BUFFALO-BERRY

THE buffalo-berry, *Lepargyrea argentea* (Nutt.) Greene, a native fruit of North Dakota, has been found to contain an abundance of vitamin C, as determined by the method of Bessey and King,[1] as adapted for the Evelyn photoelectric colorimeter by Bessey[2] and Morell.[3] The ripe fruit, on a fresh basis, apparently contains well over 150 mgs of vitamin C per 100 grams. One sample of fruit, picked on October 15, 1942, contained 184 mgs of vitamin C per 100 grams.

This fruit is usually consumed in the form of a jam or a jelly. Although destruction of vitamin C occurs, samples of buffalo-berry jam contained 80 to 90 mgs of vitamin C per 100 gms.

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SCIENTIFIC BOOKS

VITAMINS

Chemistry and Physiology of the Vitamins. By H. R. ROSENBERG. xix + 674 pages. New York: Interscience Publishers, Inc. 1942. $12.00.

THIS is an encyclopedic monograph treating practically all the substances commonly called vitamins; and, in general, each of them on the same comprehensive plan—nomenclature, chronology, occurrence, isolation, properties, specificity, synthesis, industrial methods of preparation, determination, "standards" (units of quantitative expression), metabolism and requirements in nutrition. Different aspects are, however, obviously treated with very different degrees of fullness; and, in the opinion of this reviewer, of critical acumen as well. In his preface the author introduces himself as having "been connected, at some time or other, with the development of many of the vitamins known to-day"; and this phrase well foreshadows the strength and weakness of the author's handling of the broad and many-sided subject he has undertaken. The book gives a relatively complete account of the "development" of each vitamin from a biochemical discovery into a commodity to be patented, if possible, and manufactured for commerce; while the treatment of the significance of the vitamins in nature, and in the scientific undertaking "to render more intelligible the world in which we live," is disappointingly sketchy; and the generalizations as to vitamin values of foods are unwarrantably dogmatic in form and, at least in this reviewer's opinion, excessively pessimistic in substance.

The volume contains the materials for a useful reference handbook on the industrial chemistry of the vitamins. It seems unfortunate that in so many of the chapters this useful material is intermingled with compilations of material from the physiological or nutritional literature of the vitamins which latter can hardly be said to be handled with a firm grasp nor with freedom from errors and inconsistencies, *e.g.*, on pages 34; 57 and 60 *vs.* 75; 100; 123; 180; 190; 198; 199; 338. Whether all these will be obvious to the reader will naturally depend largely upon the knowledge of vitamins which he already

[3] In the absence of the junior author, C. C. Albritton, Jr., the senior author should be held responsible for this reply.

[1] O. A. Bessey and C. G. King, *Jour. Biol. Chem.*, 103: 687, 1933.

[2] O. A. Bessey, *Jour. Biol. Chem.*, 126: 773, 1938.

[3] S. A. Morell, *Indust. and Eng. Chem., Anal. Ed.*, 13: 793, 1941.

possesses. Any that are not obvious are, of course, the more unfortunate on that account.

Although they were published early in 1941, the "Recommended Allowances" of the National Research Council's Committee on Food and Nutrition (now Food and Nutrition Board) do not appear in Dr. Rosenberg's sections on "requirements." This omission not only impairs the value of these sections but illustrates further the unevenness of the book.

On the other hand, the sufficiently advanced and critical reader may find this book useful for its conveniently summarized chronologies, its many footnote references to original sources, its comprehensive compilations of the series of synthetic steps leading to industrial production of individual vitamins, and its extended listing of patents.

H. C. SHERMAN

ORGANIC CHEMICAL EXPERIMENTATION

Semimicro and Macro Organic Chemistry. By NICHOLAS D. CHERONIS. 388 pp., 63 illustrations, 12 tables, 40 pages of questions, 15 report forms. Thomas Y. Crowell Company. 1942. $2.75.

THIS laboratory manual, containing semimicro and macro methods of 70 organic preparations, constitutes the first systematic and practical application of semimicro methods of experimentation to general organic preparative methods. The author, beyond any doubt, demonstrated "that it is possible to attain all the objectives of laboratory practice in elementary organic chemistry, using the semimicro technic. In addition, this method offers the following advantages over the traditional method: (1) it permits better adaptation of the laboratory work to the varying needs of the students; (2) it teaches students greater care, cleanliness and manipulation; (3) it is more economical; and (4) it reduces substantially the seriousness of possible accidents since the quantities of reagents and size of equipment are only some 10 to 20 per cent. as great as with macro methods." The author also appears to have made the substantially correct observation that over-all application of the classical organic micro preparative methods of Behrens and Kley, Emich, and others, appear as yet not practical enough for general organic preparative laboratory practice and that for this purpose semimicro methods constitute the ideal solution, thus substantiating similar observations made by the reviewer in the teaching of qualitative organic analysis.

This laboratory manual, although still retaining one macro method for each procedure, must be heralded as a landmark in the field of organic chemical experimentation which may be expected to lead eventually to a complete replacement in the teaching of macro methods used heretofore in this field, thus paralleling the successes of semimicro methods in qualitative inorganic and of the micro methods in quantitative organic analysis.

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AMATEUR SCIENCE

The Amateur Scientist: Science as a Hobby. By W. STEPHEN THOMAS. Pp. 291. New York: W. W. Norton and Company, Inc. 1942. $3.00.

As long ago as 1890 the writer and another boy in second-year high school arranged with a devoted teacher, who didn't consider her day's work over at four P.M., to remain after school and assist them in some simple chemical experiments in which they had become interested. They had never studied "high school chemistry." A very few years later, one of these boys continued his chemical studies by taking evening courses in the Massachusetts Institute of Technology. Eventually he became chief metallurgist in one of the laboratories of the General Electric Company. Probably few of the staff of university-trained chemists and metallurgists who served under him realized that he owed his position chiefly to the encouragement of a boy's spontaneous amateur interest in chemistry.

Doubtless instances similar to the above could be multiplied many times. One can never forget that the electrical process of making aluminum was discovered by a young man twenty-two years old, Charles M. Hall, whose boyish scientific interests were encouraged. For the advancement of science it is a fundamental thing to stimulate and encourage an interest in any aspect of science wherever it manifests itself, and especially in young people.

Dr. Frederick P. Keppel, while president of the Carnegie Corporation of New York, instituted an inquiry into methods of promoting an interest in science among amateurs, and a committee on organization, with Dr. Edwin G. Conklin as chairman, made a survey of the Philadelphia region. One result of Dr. Keppel's work was that the American Philosophical Society, at Philadelphia, cooperating from the beginning, appointed a Committee on Education and Participation in Science, with Dr. Conklin as chairman. This committee organized an executive staff with W. Stephen Thomas as executive secretary, on a full-time basis, beginning on June 1, 1939. This committee began to issue a series of bulletins on "Activities in Science in the Philadelphia Area." The bulletin for February 1, 1942, contained the disappointing notice that the work of the Committee on Education and Participation in Science had to be discontinued because Mr. Thomas had entered the Army.

Fortunately, however, before he terminated his work with the Philosophical Society, Mr. Thomas had prepared for publication a book of 291 pages, "The

Amateur Scientist: Science as a Hobby." The foreword is by Dr. Conklin. A certain number of copies have been distributed to various educational and scientific institutions by the Carnegie Corporation. The eight chapters of the book deal with Science and Ourselves, Science as a Hobby, Who is the Amateur Scientist?, The Amateur Scientist and the Community, Organizations of Amateur Scientists, Research and the Amateur Scientist, Sample Programs for Amateur Research, The Amateur Scientist and the Future.

The book sets forth the aims, methods and results, of a two and one-half years survey of amateur science in the Philadelphia region and the broader conclusions to be drawn from it—especially the great importance of encouraging people to be "scientifically-minded" when confronted with social, political and international problems, as well as with the problems of science. "Plainly," says the author, "the scientist is either indifferent to his relationship to the public or else he shies away from interpreting his findings to the layman for fear of being misunderstood."

The first chapter sets forth briefly how our daily lives are affected by modern science and notes how wide-spread is the amateur interest as indicated by studies made by the American Association of Adult Education. The second chapter discusses why laymen so often adopt one of the sciences as a recreational pursuit. The educational importance is stressed of having a program of public education that equips one not only for a vocation, but to spend his spare time with profit and interest—to live as well as to make a living.

One who might be inclined to question the value to science of encouraging the interest of amateurs, says the author, need only be reminded that Isaac Newton was a public official, Leewenhoek a Dutch merchant, Benjamin Franklin a printer, Sir William Herschel an organist, Priestley a preacher, Darwin a country gentleman, Mendel a monk, Fabre a village school teacher (p. 40). The situation in Philadelphia and vicinity is presented as a sample of what has been and is being done, but the book has a broad outlook and range, and is full of helpful suggestions for promoting and organizing the layman's interest in science. The Philadelphia program is worthy of careful study and imitation (with variations of course as to detail, etc.), and the book is to be commended to the careful attention of every one who is interested, not only in science, but in public education and public welfare.

C. STUART GAGER

BROOKLYN BOTANIC GARDEN

REPORTS

AUSTRALIAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH[1]

THE fifteenth annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia, covers the year ended June 30, 1941, and includes the financial statement as well as lists of publications of the council and of the personnel of the council and its committees and the committees concerning work in which the council is cooperating.

A large part of the council's activities is now devoted to the solution of problems arising out of the war, and to assistance and advice to various government departments and other institutions and organizations which are concerned with that effort. This applies particularly to the National Standards Laboratory, the Aeronautical Research Laboratory, the Forest Products Laboratory and the Division of Industrial Chemistry. The reference to these activities is limited to brief general statements or omitted entirely.

Plant investigations have been concerned with native or naturalized plants as alternative sources of fiber, particularly as a substitute for jute, and investigations aimed at ascertaining the difference between the fiber from various Linum (flax) strains of good type or being continued. A survey is in progress to ascertain the position with regard to domestic supplies of vegetable and farm crop seed and methods of maintaining them. Weed investigations have shown that the St. John's wort can be virtually eliminated wherever subterranean clover can be grown successfully, but spraying with chemicals has failed to control an infestation of blackberry, and the work on both nutgrass (*Cyperus rotundus*) and mintweed (*Salvia reflexa*) has indicated that chemical sprays are of no value in controlling either plant. Field experiments on the control of take-all and the root-rot of wheat have continued at three sub-stations.

The work on the chemistry of tobacco at the University of Sydney was discontinued, as well as the study of disease resistance by the section of genetics. Work on the yellow dwarf disease, however, has continued actively, as well as investigations on smoking quality and physiological investigations. Fruit investigations have included an extension of the experiments on wax coatings for apples, and a reorganization to coordinate the wider attack on this problem organized by the division of food preservation. A re-examination and summary of the results of the work carried out in Tasmania on the brown-heart

[1] From *Nature*.

problem during the last five years has been made. Extended cooperation with the Tasmanian Department of Agriculture in experiments, particularly in relation to the effect of different stocks and pruning technique on the keeping quality of apples, has also been a feature of the season.

Other investigations have been concerned with storage disorders and with fruit physiology in relation to keeping quality and seasonal climate. Work on pre-storage treatments to increase the cool- and common-storage capacity has now been greatly expanded. A survey is also in progress in coastal Queensland areas to locate indigenous or naturalized plants, which may be sources of certain drugs such as caffeine, ephedrine, cocaine, quinine substitutes and substances such as derris. Attention has also been given to potato virus diseases, particularly to virus X, and trials have been made on fungicidal dusts for the treatment of maize seed. The dusts had no perceptible effect on germination or vigor of early growth, except at Canberra, and then only when inferior or diseased seed was used.

Laboratory work of the division of economic entomology on weevil control has been concentrated chiefly on a study of mineral dusts, and gratifying results have been obtained with one or two effective non-silicious dusts readily available in Australia. Milling tests with treated wheat indicated that the dust is removed in the ordinary mill treating process, although the dust treatment has certain disadvantages such as its effect on the appearance and free-running properties of the grain. Although the division does not possess the special equipment required for accurate assessment of the relative toxicity of fumigants, a series of experiments with simple apparatus has been carried out to determine the susceptibility to fumigants of Calandra and *Rhizopertha dominica* to such fumigants as di-β-chloroethyl ether, chloropicrin, ethyl formate, *o*-dichlorobenzene, carbon disulfide, ethylene dichloride and carbon tetrachloride. Results indicate that Rhizopertha is more susceptible to all these fumigants than either of the Calandra species. Practical fumigation tests of infested wheat in concrete silos have been carried out with ethyl bromide and with Cyanogas G, the latter appearing to give almost complete control of *Rhizopertha dominica.* The sterilization of stack sites and sheds with petroleum oil and tar oil emulsions indicates that only those emulsions containing *o*-dichlorobenzene and di-β-chloroethyl ether or their mixtures with creosote and oil have given consistently good results for killing the developmental stages of *C. granaria, C. oryzae* and *R. dominica,* and good results have been obtained with emulsions of carbon disulfide or *o*-dichlorobenzene with crude naphthalene in the treatment of wheat shed floors when these are of loose earth in which infested grain may be buried.

In investigations on sheep blowfly, considerable progress has been made in compounding two useful dressings, the study of repellants and in an investigation of the breeding-ground of *Lucilia cuprina,* which is responsible for 90 per cent. or more of strikes in Canberra. Toxicity studies using the contact toxicity technique indicate that 0.4 per cent. of arsenious oxide is completely non-toxic to prepupae when immersed for 30 minutes at 23° C., and αα-dipyrridyl is almost as high in toxicity as nicotine, dinitro-*o*-cyclohexyl-phenol and proflavine being only slightly toxic. Other entomological investigations have been concerned with the eradication of cattle ticks, insecticides for the control of wheat weevil and on the oriental peach moth. Animal health and nutrition investigations have covered pleuro-pneumonia of cattle, mastitis in dairy cattle, studies on phenothiazine as an anthelmintic and blowfly problems and coast disease of sheep.

The division of forest products investigation has extended its work in the field of defense, including the examination of numerous specifications for all kinds of defense and munition needs, the submission of advice on substitutes when necessary, and recommendations in regard to modified manufacturing methods or procedures; its work is claimed to have resulted in savings in imports, in the amount of timber used and in the use of timber of lower quality. Flax investigations have been enlarged and both chemical and engineering research in this field are now centered in the division. The promising work on chemical retting is being revived and problems of scutching, tow treatment, drying of retted straw and control of dew retting are also being studied.

Food preservation investigations have covered problems in the preparation and transport of boneless frozen meat, chiefly for the use of fighting services overseas, canning problems, the use of *o*-phenyl-phenol in fillers to restrict bacterial waste in stored eggs, the storage of whole egg powder, the handling, treatment and storage of fruit, etc., investigations which will in future be coordinated by a special committee representing all bodies carrying out work in this field. Protective skin coatings for fruit have been investigated, particularly the preparation of colloidal wax emulsions that leave clear bright films on drying. Chemical treatments for the control of mold wastage in stored grains have also been investigated. Fisheries investigations have covered smoking of fish, fish liver oil production and investigations on Australian tunas, pilchards, mullets, etc.

Brief reference is made to the work of the National Standards Laboratory, to aeronautical investigations

at the aeronautical laboratory, which has now been given the status of a division, and to investigations in industrial chemistry, including that on unshrinkable wool, on wool wax, utilization of minerals and on producer gas investigations, particularly the suitability of Australian hardwoods for the production of charcoal. Substantial progress has been made in building up a research organization and the development of research methods for dealing with lubrication, bearing and wear problems in Australia. The work is undertaken as cooperative research with the University of Melbourne and housed in the new chemistry school. The work of the Dairy Research Section has included a survey of the properties of Australian butter and the storage and transport of butter fat without refrigeration.

SPECIAL ARTICLES

SUBCLINICAL VITAMIN DEFICIENCY[1]

I. TISSUE ANALYSES

INDIVIDUALS subsisting upon inadequate diets generally experience a more or less prolonged period of ill-health before unequivocal symptoms of deficiency make their appearance. Recognition of their deficiency in this subclinical stage is difficult because of the vagueness and generality of their complaints. Speculation on the extent to which the general population may be affected has led therefore to a program designed to decrease the incidence of latent deficiency by increasing considerably the consumption of vitamins.

Definition of "normal vitamin requirements" has proved, however, to be a complicated problem. The suggestion that our civilized diet is not normal has made impossible the customary identification of "usual" with "normal." The essentially intracellular character of the enzymes derived from vitamins,[2] and the poorly understood equilibria between these enzymes and the body fluids, have made difficult the interpretation of vitamin analyses of blood, urine and stools. Before these indirect measurements of nutritional status can be used critically, a primary knowledge of the tissue concentrations which they reflect must be obtained.

The type of information required can be illustrated by Fig. 1. A classical curve of enzyme action is used to represent the probable relationship between tissue thiamin concentrations and the tissue functions dependent upon thiamin enzymes. The problem is to identify the position of points M, m and S, and to determine the thiamin intake necessary to maintain the concentration of enzyme at or near M under varying conditions of energy output, environmental temperature and metabolic mixture. Solution is complicated by the existence of different relationships in different tissues and in different age groups, Tables I and II.

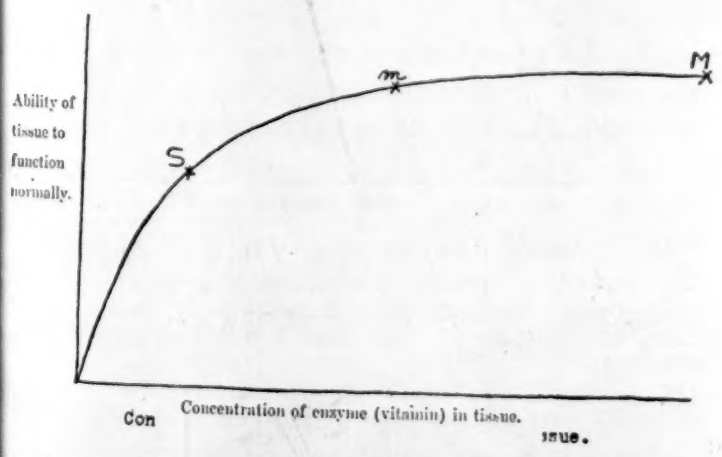

FIG. 1. Scheme of the relationship between tissue thiamin concentrations and the ability of tissues to carry on their normal functions. M = Maximum concentration of enzyme obtainable in tissues. m = Minimum concentration of enzyme compatible with normal function. S = Concentration of enzyme at which symptoms of deficiency appear.

TABLE I

SKELETAL MUSCLE THIAMIN IN DIFFERENT AGE GROUPS OF PRESUMABLY SIMILAR NUTRITIONAL STATUS

Age	Micrograms of thiamin per gram of muscle
6 month fetus	1.4
8 month fetus	1.5
Term infant	1.3
1 year	1.6
5 years	1.0
10 years	1.2
30 years	0.4
37 years	0.4
48 years	0.5
51 years	0.4

Tissues from both post-mortem and biopsy tables are available for vitamin assays. Post-mortem material permits analysis of the relationships between changes in vitamin concentrations in different tissues. Its assay is therefore a necessary preliminary to the evaluation of observations made on single tissues. Biopsy specimens are usually restricted to one tissue but are free from the unspecific effects of terminal illness and have the advantage of permitting repeated observations on ambulatory subjects. From studies of biopsy and post-mortem material a fair composite picture of the relationship between changes in vitamin

[1] Aided by grants from the R. R. Williams and R. E. Waterman Fund for the Investigation of Nutritional Disease, Research Corporation, New York City. Part II—"Micro Muscle Biopsies" and Part III—"The Thiamin Content of Micro Muscle Biopsies" were aided by a grant from the National Research Council, Washington, D. C.

[2] E. A. Evans, Jr., "The Biological Action of the Vitamins." The University of Chicago Press, Chicago, 1942.

TABLE II

CEREBRAL CORTEX THIAMIN IN DIFFERENT AGE GROUPS OF PRESUMABLY SIMILAR NUTRITIONAL STATUS

Age	Micrograms of thiamin per gram of cortical tissue
8 month fetus	0.5
Term infant	0.3
6 weeks	0.6
7 weeks	0.6
6 years	1.3
6 years	1.0
30 years	1.1
51 years	1.0
58 years	1.1

intake and changes in tissue vitamin concentrations may be constructed.

Preliminary work of this kind[3,4] has indicated that the thiamin content of skeletal muscle may serve in man as an index of thiamin nutrition. Changes in muscle thiamin in general parallel changes in other tissues, Table III. Since muscle is readily available

TABLE III

CONCENTRATION OF THIAMIN IN HUMAN TISSUE (MICROGRAMS PER GRAM) PARALLELISM BETWEEN CONCENTRATION IN SKELETAL MUSCLE AND CONCENTRATIONS IN OTHER TISSUES

Patient	Nutritional status	Heart	Liver	Kidney	Brain	Skeletal muscle
A	Good	2.3	1.1	1.7	1.0	0.4
B	Fair	1.3	1.0	1.2	..	0.2
C	Poor	0.6	0.3	0.4	0.5	0.0
D	Alcoholic Polyneuritis	Generalized symptoms: heart failure, jaundice, neuritis				0.2
E	Alcoholic Polyneuritis	Generalized symptoms				0.2
E	2 days after cessation of vitamin therapy	No symptoms				0.6

for biopsy, techniques can be developed which make repeated muscle analyses clinically feasible.[5,6] These techniques should facilitate solution of the general problem posed in Fig. 1 and furnish information concerning the frequency and severity of subclinical thiamin deficiency among the general population. Their extension to other vitamins is being investigated.

II. MICRO MUSCLE BIOPSIES

Investigation of a number of clinical problems—nutritional, metabolic and dystrophic—can be facilitated by a ready supply of skeletal muscle. The needle arrangements described by Silverman[7] can be used for muscle biopsies. For this purpose, the bevel of both the inner and the outer needle should be increased somewhat and the edges of the outer brought to a razor sharpness by honing on a hand stone.

Samples of muscle by this technique run between 5 and 15 mg, wet weight. Several specimens may be obtained through a single novocainized skin puncture. The reliability of the sampling can be verified by micro nitrogen and micro phosphate determinations. The biopsy is not unduly traumatizing and patients readily consent to its repetition. Biopsies of the gluteus maximus appear to be less painful than those made elsewhere.

III. THE THIAMIN CONTENT OF MICRO MUSCLE BIOPSIES

The yeast fermentation method devised by Schultz, Atkin and Frey[8] is admirably suited to the determination of thiamin in skeletal muscle. Pyrimidine blanks in this tissue are small, consistent, probably in fact negligible. The micro method[9] is readily converted to a lower range, Fig. 2, by utilizing standard 15

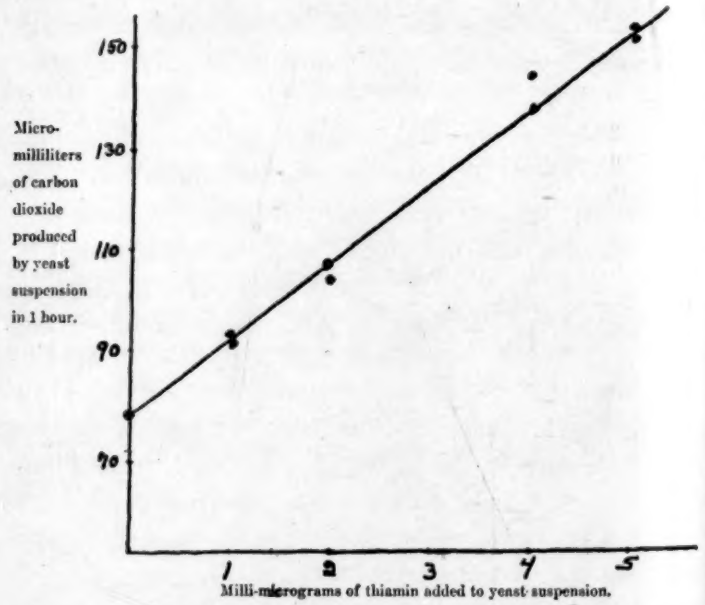

FIG. 2. Effect of thiamin, in 1 to 5 milli-microgram range, on carbon dioxide production of yeast suspension. (15 milliliter Warburg flask, 1 milliliter of nutrient medium, 1 milligram of yeast and 1 milliliter of thiamin standard.)

milliliter flasks fitted with a side-arm gas vent. This modification is sufficient to permit determination of thiamin in micro muscle biopsies secured with the Silverman needle.

Five to 15 mgs of muscle are transferred from the inner split needle to a small weighed tube. The muscle is ground, suspended in 0.02 M acetate buffer, (pH 4.8), and extracted. One milliliter of extract-suspension is pipetted into a 15 milliliter Warburg flask containing 1 mg of yeast in 1 milliliter of

[3] J. W. Ferrebee, N. Weissman, D. Parker and P. S. Owen, *Jour. Clin. Invest.*, 21: 401, July, 1942.

[4] J. W. Ferrebee, N. Weissman, D. Parker and P. S. Owen, "The Thiamin Content of Human Tissue." Association for Research in Nervous and Mental Disease, New York City, December 19, 1941. In press.

[5] This article: II. Micro Muscle Biopsies.

[6] This article: III. The Thiamin Content of Micro Muscle Biopsies.

[7] I. Silverman, *Am. Jour. Surg.*, 40: 671, 1938.

[8] A. S. Schultz, L. Atkin and C. N. Frey, *Jour. Indust. and Eng. Chem., (Anal. ed.)*, 14: 35, 1942.

[9] L. Atkin, A. S. Schultz and C. N. Frey, *Jour. Biol. Chem.*, 129: 471, 1939.

medium. The subsequent determination is carried out as described by Atkin, Schultz and Frey.[9]

Micro analyses[9] and analyses by this technique are in good agreement, Table IV. Novocain and adrenalin

TABLE IV

COMPARISON OF MICRO (8) AND SUBMICRO TECHNIQUES OF THIAMIN ANALYSIS. THIAMIN EXPRESSED AS MICROGRAMS PER GRAM TISSUE*

Cat	Date	Condition	Muscle thiamin	
			Micro analysis	Submicro analysis
Old white number 1	5/15	Normal	0.4	
		Heart 1.8, liver 2.3, kidney 2.2, Brain 1.4	0.4	..
			0.4	
Old gray number 2	6/22	Normal		0.5
			..	0.5
Old gray number 2	7/31	3 weeks semi-starvation, moderately deficient diet. Heart 1.0, liver 2.0, kidney 1.7, Brain 1.2	0.3	0.4
				0.4
			0.3	0.3
Young black number 3	6/23	Normal	..	0.7
				0.7
				0.8
Young black number 3	7/13	2 weeks semi-starvation, moderately deficient diet	0.3	0.3
			0.3	0.4
			0.3	0.3
			0.3	0.3
				0.3
				0.3
Young black number 3	7/23	3½ weeks semi-starvation, moderately deficient diet	0.22	0.27
			0.23	0.27
			0.22	0.25
			0.23	0.26
				0.25
				0.26
Young black number 3	7/27	2 days after subcutaneous injection of 2 mg. of thiamin	0.96	1.20
			0.99	1.15
			1.08	1.20
			1.08	1.10
				1.18

* For micro analyses 1 to 2 grams of skeletal muscle were removed surgically under nembutal anesthesia; for submicro analyses 5 to 15 milligrams of muscle were removed with the Silverman needle.

used in skin anesthesia do not interfere with measurements by the yeast fermentation method. When the muscle is abnormal, aliquots of suspension may be used for micro nitrogen or phosphorus determinations[10] and the thiamin concentration expressed in micrograms per milligram of muscle nitrogen or phosphorus.

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VARIABILITY IN THE PAIN THRESHOLD

HARDY, Wolff, Goodell and Schumacher have reported an unusual series of observations on the absolute pain threshold in man. Using radiant heat as a stimulus, they found only slight variability in pain thresholds, either for repeated measurements made upon the same person,[1] or for measurements made upon different subjects.[2] Furthermore, this threshold pain was said to be so uniform in quality that it was easily recognized even by untrained subjects. These authors attribute the commonly observed differences in pain sensitivity to conditions governing "reaction" to pain, rather than to fundamental differences in perceptual sensitivity as such.

In order to test the generality of the conclusion that pain thresholds are uniform, the writer has used electric current in a series of pain threshold measurements made upon 15 college women. An electronic device of the type recently described by Fender[3] supplied the current. This instrument produces condenser discharges which are amplified and delivered through resistance of such high order that variations in the subject's skin resistance have little effect upon the current flowing in the stimulus circuit. An A.C. microammeter measures this current directly. Current strength may be varied continuously by changing the resistances in series with the subject. The electrodes consisted of a silver disc 17 mm in diameter and a rounded silver wire 1 mm in diameter, embedded 8 mm apart in a piece of bakelite.

Threshold determinations were made on four skin areas, two each on the dorsal surface of the left forearm and on the forehead, in the following order: arm, head, head, arm. The "method of minimal changes" was used, with two "ascending" and two "descending" series for each spot. On a second day the experiment was repeated with 14 of the 15 subjects.

The mean of 240 threshold determinations made on the first day—irrespective of subject or of skin area—was 15.96 microamperes. The range of the thresholds was from 2.25 to 65 microamperes, while the standard deviation was 8.78 microamperes. If these variability indices are converted into relative units, the range represents a variation about the mean of approximately -80 to $+300$ per cent., while the standard deviation is ± 55 per cent. of the mean. The repetition of the experiment yielded slightly higher figures for the mean and standard deviation (18.18 ± 10.14), but the relative variability remained almost unchanged (S.D./Mean = 56 per cent.).

The variability of these pain threshold measurements is markedly greater than that reported by Hardy and his collaborators for thermal stimuli. Their standard deviation represented a variation

[10] Nessler and Kuttner-Lichtenstein techniques modified (see O. Schales, R. V. Ebert and E. A. Stead, Jr., *Proc. Soc. Exp. Biol. and Med.*, 49: 1, 1942; T. D. Fontaine, *Jour. Indust. and Eng. Chem. (Anal. ed.)*, 14: 77, 1942) and adapted to Coleman spectrophotometer.

[1] J. D. Hardy, H. G. Wolff and H. Goodell, *Jour. Clin. Invest.*, 19: 649, July, 1940.

[2] G. A. Schumacher, H. Goodell, J. D. Hardy and H. G. Wolff, SCIENCE, n. s., 92: 110, August 2, 1940.

[3] F. A. Fender, SCIENCE, n. s., 89: 491, May 26, 1939.

about the mean of ±1 per cent., whereas the corresponding coefficients of variation in our two sets of measurements were greater than 50 per cent. But their frequency distribution was based upon averages of all threshold determinations for each subject, and such values would normally show less variation than a distribution of single threshold measurements. Similar average thresholds have been computed from our data, and means, standard deviations, and coefficients of relative variability have been determined. For the first day's averages, these three measures were as follows, in microampere units: mean, 16.06; standard deviation, 7.86; S.D./Mean, 49 per cent. Corresponding values for the second day were: mean, 18.0; standard deviation, 8.12; S.D./Mean, 45 per cent. These indices of relative variability are somewhat lower than those for the single measurements, but they are still almost fifty times as great as the value reported for thermal stimulation.

These results show definitely that pain thresholds for this form of electrical stimulation are not uniform or constant in different individuals. A further question arises as to the constancy of sensitivity in the same individual. Does the subject with a low threshold for one series of measurements continue to exhibit the same level of sensitivity in subsequent tests in the same area, in different areas, or on different days? In order to test the reliability of these thresholds, rank-difference correlation coefficients have been computed between several series of measurements. First, the averages of all thresholds for one day were correlated with those for the second day, and the coefficient was .55. This represents a moderately high degree of correlation, but it is far too low for accurate prediction of an individual's standing from one day to the next. It should be noted, however, that one half of the subjects had almost identical ranks on the two days, while the other half exhibited the variability which lowered the correlation.

The consistency of the two sets of threshold measurements made upon the same spot was next determined. The correlations were high between the averages of each of these two series, for all four of the spots tested on the first day. The coefficients were .86, .91, .89 and .94, for arm, head, head, arm, respectively. But the correlations between average thresholds for different spots in the same body area were much lower, varying from .32 to .44. Finally, averages of all threshold determinations made for the arm on a given day were correlated with corresponding averages for the forehead. The correlations of two sets of such values, secured on the two days, were exactly the same, the coefficient in each case being .60.

It is clear from these correlations that the electrical pain threshold of an individual may vary considerably from day to day, and from one skin area to another. Certain subjects are relatively stable, while others fluctuate over a wide threshold range. Further study of the conditions of such individual variability is needed.

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THE EFFECT OF SODIUM BICARBONATE ON THE THIAMINE CONTENT OF PEAS[1]

IT is generally believed by nutritionists that cooking with sodium bicarbonate results in the destruction of a large proportion of the thiamine content of foods. In order to obtain definite data on this subject, the experiments recorded in Table 1 were carried out with fresh and frozen peas.

TABLE 1*

Type of peas and method of cooking	No. of tests	Time of cooking	pH of water after cooking	Thiamine in gamma		
				Per 100 gm peas	In total cooking water	Total
		min.				
Frozen-Type I†						
Raw	3					408
Water-cooked	3	6	7.66	326	90	416
Sodium bicarbonate-cooked	3	4	8.77	330	44	374
Frozen-Type II†						
Raw	1					351
Water-cooked	1	6		238	102	340
Sodium bicarbonate-cooked	1	4	8.70	193	25	218
Fresh						
Raw	4					333
Water-cooked	4	17	7.29	257	78	336
Sodium bicarbonate-cooked	4	8	8.84	258	63	321

* In all tests 85 gms of peas were cooked with 180 cc of water. In sodium bicarbonate tests 0.22 gm of sodium bicarbonate was added.

† Type I represents a brand of peas prepared by tunnel freezing; Type II, plate freezing.

The average time necessary to complete the cooking of the peas was determined in separate tests where it was found that sodium bicarbonate greatly reduces the time of cooking. Thiamine was determined by a modification of the fermentation procedure of Schultz, Aiken and Frey.[2] The applicability of the above method of biochemical determination was confirmed by bioassay of dried ground water-cooked and sodium bicarbonate-cooked peas by the method of Kline, Hall and Morgan.[3]

The greater loss in thiamine found in Type II of the frozen peas is probably to be ascribed to the partial mashing of the peas by this method of freezing.

[1] This investigation was aided by a research grant from the Church and Dwight Company, Inc.

[2] A. S. Schultz, L. Aiken and C. N. Frey, *Ind. Eng. Chem., Anal. Ed.*, 14: 35, 1942.

[3] O. L. Kline, W. L. Hall and J. F. Morgan, *Jour. Ass. Off. Agr. Chem.*, 24: 147, 1941.

In another series with fresh peas which were overcooked to the extent of rupture of the hulls, an average destruction of 35 and 57 per cent. of the original thiamine occurred when cooked with water or water and sodium bicarbonate, respectively.

The experiments indicate that no greater destruction occurs in the thiamine remaining in the intact pea after cooking with sodium bicarbonate than when water alone is employed. Slightly greater destruction results in the thiamine leached out of the pea during cooking. The loss only amounts to 8.3 per cent. in the frozen peas and 3.6 per cent. in the fresh peas cooked with sodium bicarbonate.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS FOR DETERMINATION OF THE BACTERIAL CONTENT OF AIR[1]

A NUMBER of devices have been employed for determining the bacterial content of air. To be satisfactory, such a device must trap all or nearly all the air-borne microorganisms, must allow quantitative recovery of the bacteria for counting, must allow sampling of a large volume of air so that the sample obtained is representative, and must be simple and convenient to operate under field conditions.

The Wells centrifuge has perhaps been used most widely for bacterial air analysis. Theoretical considerations and experimental data have been put forth by Phelps and Buchbinder[2] showing that only those bacteria carried on droplet nuclei greater than a certain minimum size can be retained by the Wells Centrifuge. Wheeler, Foley and Jones[3] have suggested bubbling air through glass beads immersed in broth, as had been done by Robertson and associates.[4] In experiments testing the recovery of bacteria from room air, Wheeler showed that the glass beads device recovered eight times as many bacteria per cubic foot of air as the Wells centrifuge. A discussion of the merits of other bacterial samplers is given by Bourdillon, Lidwell and Thomas.[5]

The apparatus described in the present paper and pictured in Fig. 1 utilizes the principle of atomization to coat the bacterial particles with a layer of liquid.[6] The mist thus produced is carried into the second chamber of the collector, where it is bubbled through liquid which absorbs the droplets.

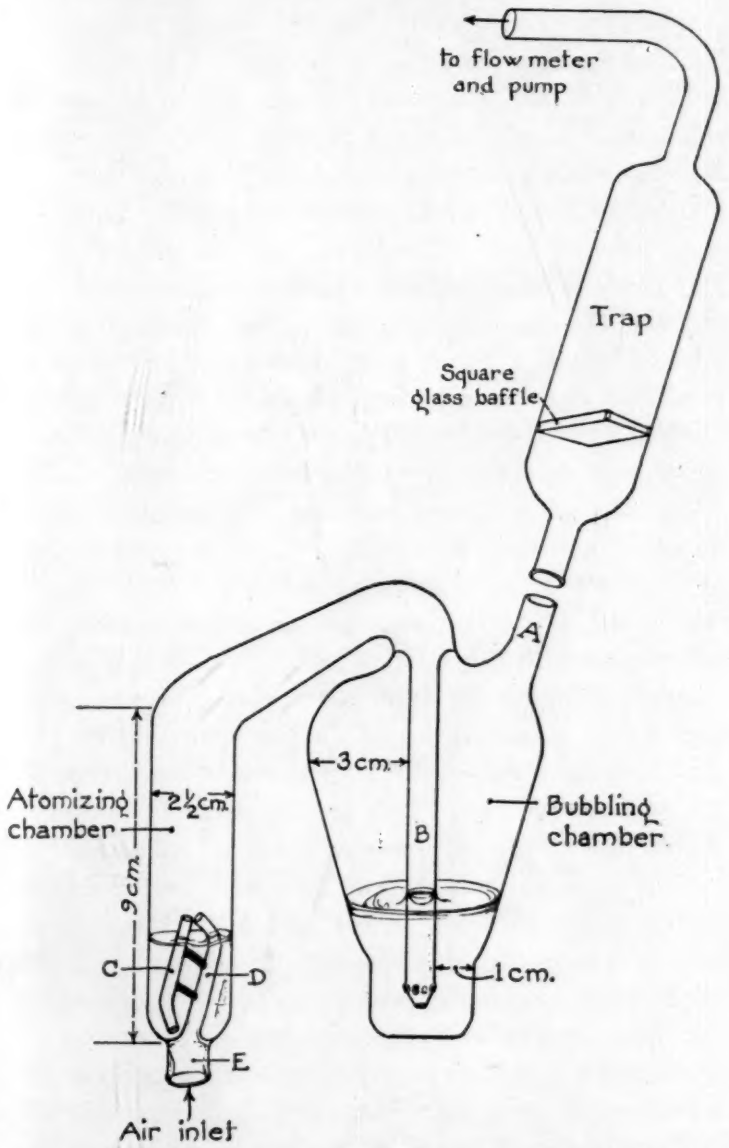

FIG. 1. Atomizer Collector for bacterial air analysis. The capillary, C, is about 1 mm, inner diameter; D is about 1.5 mm, inner diameter, at the tip. At the bottom of tube B are five holes 1 mm in diameter.

The procedure of operation is as follows: Fifteen cc of sterile broth plus two drops of sterile olive oil are pipetted into opening A of the apparatus which

[1] This investigation was aided in part through the Commission on Cross Infections in Hospitals, Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army, Preventive Medicine Division, Office of the Surgeon General, United States Army.

[2] E. B. Phelps and L. Buchbinder, *Jour. Bact.*, 42: 321, 1941.

[3] S. M. Wheeler, G. E. Foley and T. Duckett Jones, SCIENCE, 94: 445, 1941.

[4] O. H. Robertson, Edward Bigg, B. F. Miller, Zelma Baker, SCIENCE, 93: 213, 1941.

[5] R. B. Bourdillon, O. M. Lidwell and J. C. Thomas, *Jour. Hygiene*, 41: 197, 1941.

[6] The Palmer water sampler for dust collection also has made use of this principle, G. T. Palmer, *Amer. Jour. Public Health*, 6: 54, 1916. S. H. Katz, G. W. Smith, A. M. Myers, L. J. Trostel, Margaret Ingels and Leonard Greenburg, *Pub. Health Bull.*, No. 144, 1925.

has been sterilized by autoclaving. Olive oil prevents the building up of foam masses, which would cause loss of the scrubbing fluid through bubbling over. Sufficient fluid is forced up tube B (either by tilting or by applying gentle air pressure at A) and poured into the atomizing chamber until the liquid level reaches a point about five mm below the top of the capillary tube C. The apparatus is then connected with sterile precautions to the trap[7] with a short piece of rubber tubing and air is drawn through the system by means of a small suction pump[8] at a rate measured by a calibrated flowmeter.

The air enters the inlet E and is directed through nozzle D into a jet which blows across the capillary tube C, as is done in the Graeser[9] atomizer. Liquid is thus drawn up into the capillary and atomized into the air stream. The droplets so produced either fall back into the liquid in the first chamber or else are trapped in the second chamber, where the air is bubbled through the holes at the bottom of tube B.

It was found convenient to take 10- to 15-minute samples at a rate of about three quarters of a cubic foot per minute. At the end of this time the atomizer is tilted so that all the fluid is poured into the bubbling chamber and trap. The liquid may be poured back and forth to wash off any bacteria remaining on the walls of the chambers and trap. Two tenths, 0.5 and 1.0 cc portions of the fluid in the sampler are removed for blood agar pour plates. From these plate counts the total number of bacteria in the sample are computed, and since the air volume is known, the bacterial count per cubic foot of air may be calculated. It is necessary to apply a correction factor because of loss of fluid due principally to evaporation. This correction factor is nearly constant for different samplers and varies with the relative humidity. For 10 cubic foot air samples the fluid loss varies between 1.8 cc and 3.2 cc at humidities of 70 per cent. and 30 per cent., respectively, so that an average correction of 2.5 cc may be used. This loss apparently does not interfere with the efficiency of bacterial collection.

This bacterial air sampler has been tested extensively in laboratories, offices and lecture rooms, as well as in unoccupied rooms into which broth cultures of bacteria or dried dust-suspended microorganisms had been sprayed. The completeness of removal of bacteria from the air was determined by passing the air emerging from the exhaust end of the trap through various bacterial sampling devices to determine the percentage of bacteria which had escaped. The data of Table I are representative of the results obtained.

[7] Purchasable from scientific supply houses. The trap may be sealed directly to the apparatus.

[8] Suction pump was purchased from V. Mueller Company, Chicago, and was driven by a 1/6 H.P. motor.

[9] J. B. Graeser and A. H. Rowe, *Amer. Jour. Dis. Child.*, 52: 92, 1936.

TABLE I

Kind of air sampled	Arrangement of samplers	Bacteria per cubic foot
Normal air of inhabited room	Atomizer sampler with its exhaust connected to a Wheeler glass beads sampler	Atomizer sampler: 508 Wheeler sampler: 6.5
Air into which a mixture of Staphylococcus Albus and Pneumococcus Type I broth cultures was sprayed	Two atomizer samplers in series	*1st atomizer sampler:* 22,400 staphylococci 4,080 pneumococci *2nd atomizer sampler:* 71 staphylococci 51 pneumococci

Relative completeness of collection was also tested by simultaneously sampling the air of a room with several different types of bacterial collectors. Data from a typical experiment are presented in Table II.

TABLE II

COMPARISON OF EFFICACY OF BACTERIAL COLLECTION BY THE WELLS CENTRIFUGE, THE WHEELER GLASS-BEADS COLLECTOR, AND THE ATOMIZER SAMPLER. IN EACH EXPERIMENT THE COLLECTORS WERE OPERATED SIMULTANEOUSLY AT THE SAME LOCATION IN THE ROOM

Kind of air sampled	Samplers compared	Bacteria per cubic foot
Normal room air	Wells Centrifuge	9.3
	Atomizer Sampler	160.00
Room air into which a suspension of Staphylococcus Albus and Beta Hemolytic Streptococcus Group C had been sprayed	Wheeler Glass-beads Sampler	46,800
	Atomizer Sampler	53,040

On the average, the Wheeler sampler recovered 86 per cent., and the Wells centrifuge 15 per cent. of the bacteria collected by the atomizer sampler.

The atomizer type of bacterial sampler here described has been found very simple and convenient to operate. Loss of a sample through contamination or other reasons almost never occurs. This sampler can be easily made by a competent glass blower. The auxiliary equipment is inexpensive and available.

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BOOKS RECEIVED

HUMPHREYS, W. J. *Ways of the Weather.* Illustrated. Pp. 400. The Jaques Cattell Press. $4.00.

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